250 MS/s Dual Channel Digital Storage Oscilloscope

PM3320A

Operating Manual

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880401

MAT2411

PHILIPS

IMPORTANT

In correspondence concerning this instrument please quote the type number and serial number as given on the type plate.

<u>NOTE:</u> The design of this instrument in subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

CONTENTS

6.0 CHARACTERISTICS

LIST OF FIGURES

ARRANGEMENT OF MANUAL

This Operating Manual is arranged in such a way that the essential information on safety and operating procedures is immediately available in the first chapters.

You are strongly advised to read Section 3.2. SAFETY INSTRUCTIONS thoroughly before installing your oscilloscope.

Operating information is given in the remainder of Chapter 4.

Complete information for preventive maintenance on the instrument can be found in Chapter 5. This is followed by details of the functional, mechanical and environmental data, listed in Chapter 6, Characteristics.

Finally, additional information regarding the various versions of the instrument and accessories is given in Chapter 7, and Chapter 8. respectively.

1.0 OPERATORS SAFETY

Read this page carefully before installation and use of the instrument.

1.1 INTRODUCTION

The instrument described in this manual is designed to be used by properly-trained personnel only. Adjustment, maintenance and repair of the exposed equipment shall be carried out only by qualified personnel.

1.2 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally-accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

1.3 CAUTION AND WARNING STATEMENTS

CAUTION: is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.

WARNING: calls attention to a potential danger that requires correct procedures or practices in order to prevent personnel injury.

1.4 SYMBOLS

⚠ Read the operating instructions.

1.5 IMPAIRED SAFETY PROTECTION

Whenever it is likely that safety-protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation. The matter should then be referred to qualified technicians. Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

2.0 INTRODUCTION

This compact dual channel digital storage oscilloscope features an extensive sampling rate of 250 Megasamples/s with a vertical bandwidth of 200 MHz and a vertical resolution of 10 bit.
An outstanding feature is the AUTO-SET pushbutton facility, which automatically sets various controls of the instrument to suit the input signal value. In this way, optimum ease of operation is obtained as the input signal immediately presents a correct, stable display on the bright C.R.T. screen.
The brightness is independent of the time base settings.
The M68000 microprocessor gives a wide choise of measurement and display possibilities, which can be selected via the ergonomic designed front panel.

MAT2411

Figure 2.1 250 Megasamples/s digital storage oscilloscope.

The oscilloscope is provided with integrated circuits (including thin-film circuits), which guarantee a highly stable operation.

Furthermore, connection to the local mains is simplified by a tapless switched-mode power supply that covers most voltage ranges in use: 90 V...264 V a.c.

All these features make this oscilloscope suitable for a wide range of measuring applications.

3.0 INSTALLATION INSTRUCTIONS

3.1 INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damage has occured during transport. If the contents are incomplete, or there is damage, a claim should be filed with the carrier immediately, and the Philips Sales or Service organisation should be notified in order to facilitate the repair or replacement of the instrument.

3.2 SAFETY INSTRUCTIONS

3.2.1 Earthing

Before any connection to the input connectors is made, the instrument shall be connected to a protective earth conductor via the three-core mains cable; the mains plug shall be inserted only into a socket outlet provided with a protective earth contact. The protective action may not be negated by the use of an extension cord without protective conductor.

WARNING: Any interruption of the protective conductor inside or outside the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.

When an instrument is brought from a cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

3.2.2 Mains voltage cord and fuses

Different power cords are available for the various local mains voltage outlets.
The power cord version delivered is determined by the particular instrument version ordered (see also Chapter 7).

NOTE: If the mains plug has to be adapted to the local situation, such adaption should be done only by a qualified technician.

This oscilloscope has a power supply that covers most voltage ranges in use: 90 V...264 V a.c. (r.m.s.). This obviates the need to adapt to the local mains voltage by means of switch setting.
The mains frequency range is 45 Hz...440 Hz.

WARNING: The instrument shall be disconnected from all voltage sources when replacing a fuse.

Mains fuse rating: 2.5 A delayed-action

The mains fuseholder is located on the rear panel (see Fig. 3.1.). If the mains fuse needs replacing, proceed as follows:
- switch the instrument off and disconnect it from the mains voltage.
- remove the inner part of the fuseholder by means of a screwdriver.
- fit a new fuse of the correct rating and refit the inner part of the fuseholder.

WARNING: Make sure that only fuses of the required current rating, and of the specified type, are used for renewal. The use of repaired fuses, and/or short-circuiting of the fuseholder, is prohibited.

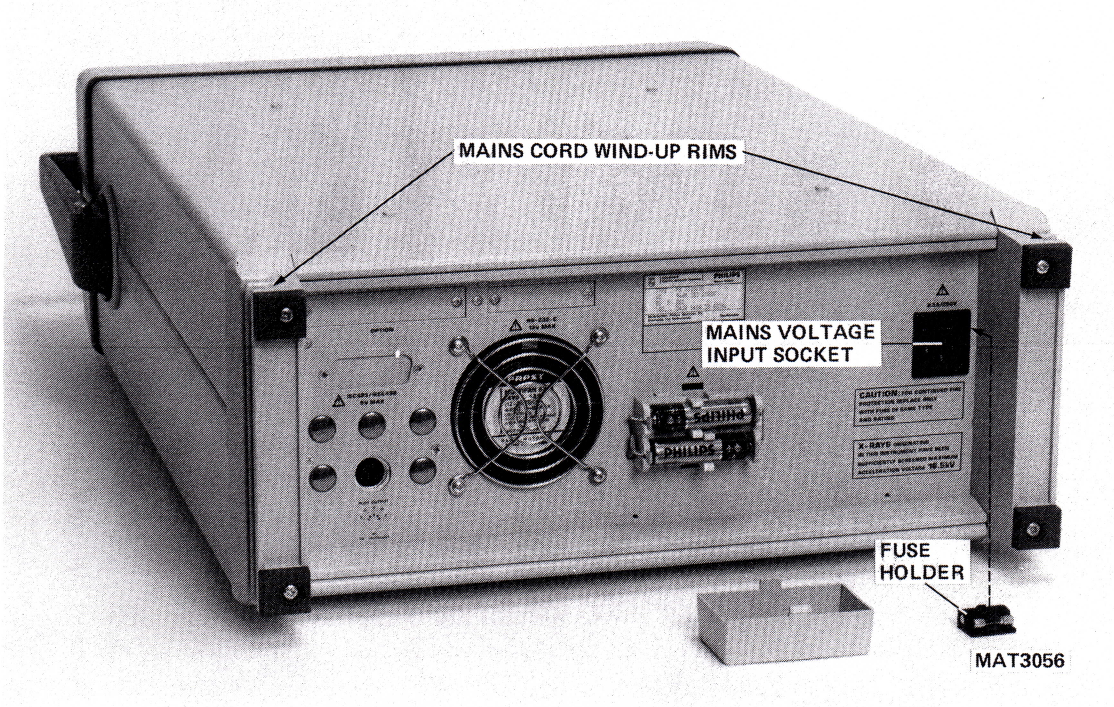


Figure 3.1 Rear view showing the fuse-holder.

3.3 MEMORY BACK-UP BATTERIES

3.3.1 General information

The memory back-up circuit has the following functions:

- after a power source interruption, or when the oscilloscope is switched off in the LOCK mode, the front-settings as well as the stored data values are saved in the internal memory.
- after the power supply is restored, the oscilloscope starts up automatically with the same front setting.

ATTENTION If the power source is interrupted while the settings are changed by the user, it might happen that the front settings are disturbed and an automatic AUTO SET is performed after switching on the instrument again.

3.3.2 Installation of batteries

To install the batteries, the following procedure must be followed:
- remove the cover of the battery compartment located on the rear panel, by pressing the two locking tongues towards each other and pulling (see Fig. 3.2.). The battery holders are now accessible.
- insert the two penlight batteries, paying attention to the polarity indication marked on the holder (also on Fig. 3.2).
  CHECK POLARITY TO ENSURE CORRECT INSTALLATION!
- refit the push-on cover to the rear panel.

NOTE: It is advisable to remove the batteries when the oscilloscope is stored for longer periods than 24 hours at ambient temperatures below -30°C or above 60°C.

IMPORTANT: Under no circumstances should the batteries be left in the oscilloscope at ambient temperatures outside the rated range of the battery specifications!

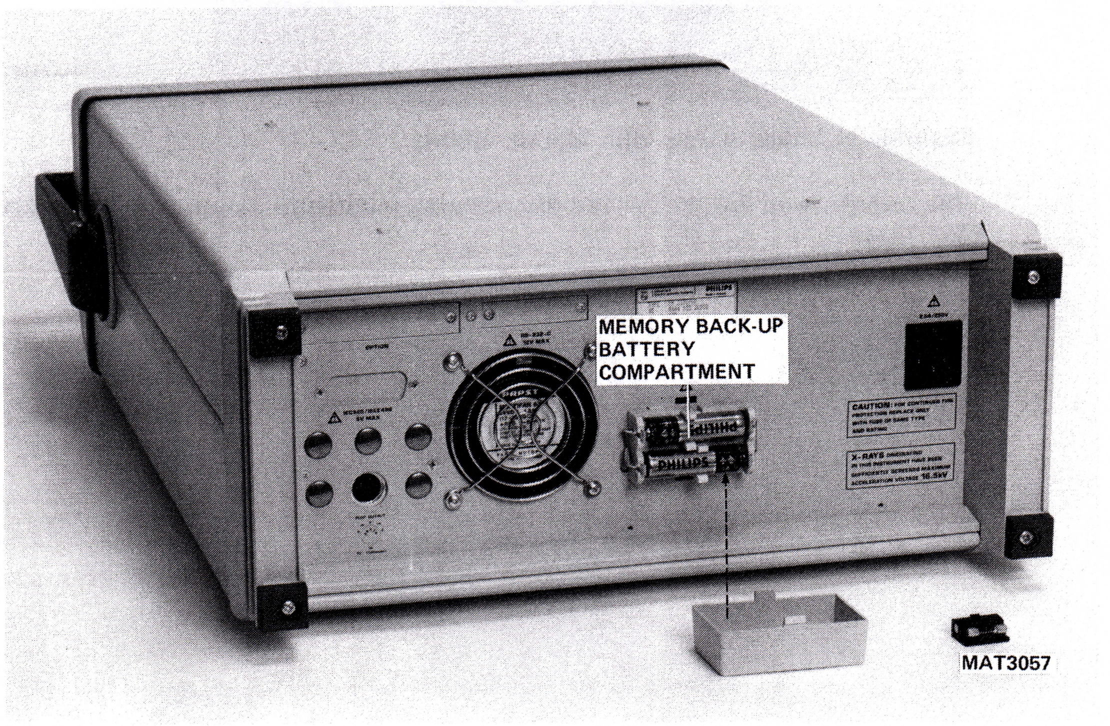


Figure 3.2 Rear view showing the battery compartment.

3.4 THE FRONT COVER

3.4.1 Removing and fitting of the front-cover

For ease of removal and fitting, the front cover has been designed as a simple push-fit on the front of the instrument. The front can be removed as follows:

- depress the pushbuttons in the brackets and turn the carrying handle as far as possible to the lower side of the oscilloscope.
- pull both clamping lips of the front cover outwards.
- lift the cover off the instrument.

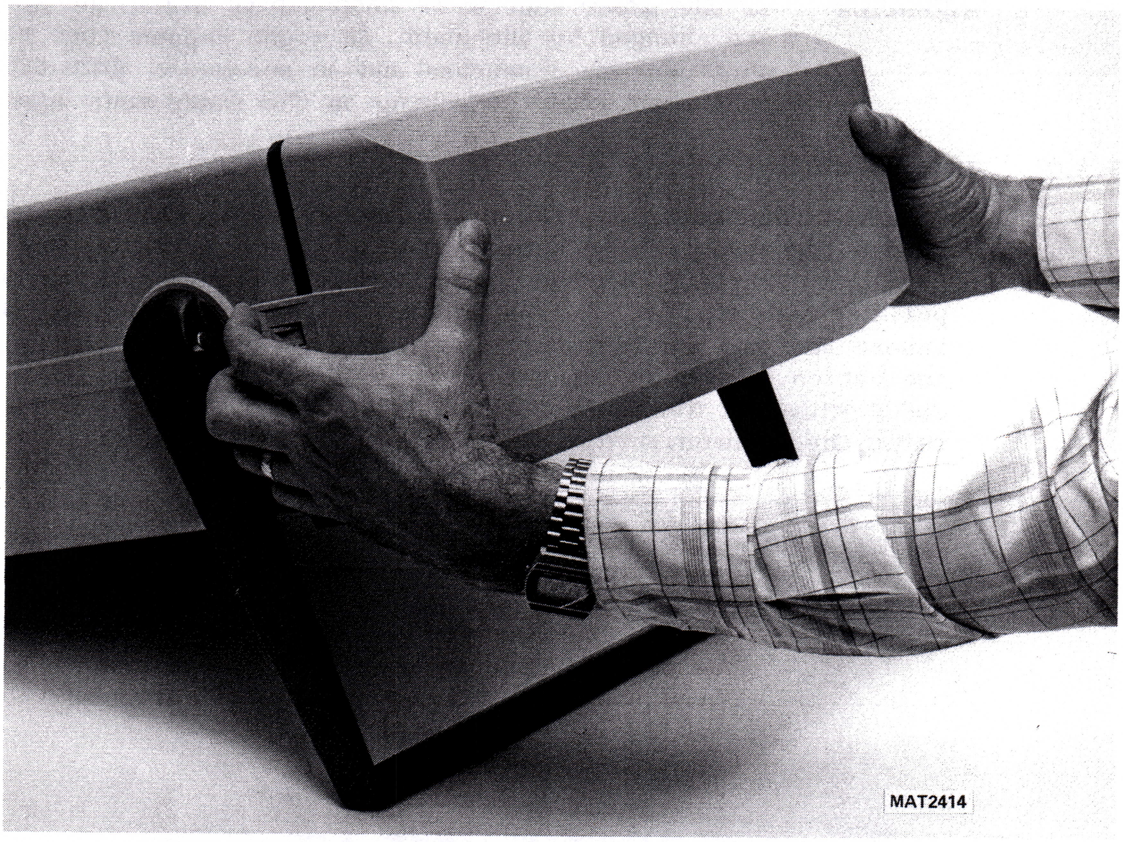


Figure 3.3 Removing the front cover.

The cover can be refitted by simply pushing it on the oscilloscope.

3.4.2 Acces to inner-cover storage space

Storage space for accessories such as probes, is available behind the inner front cover. This inner-cover can be lifted out by pressing the two locking tongues towards each other as indicated.

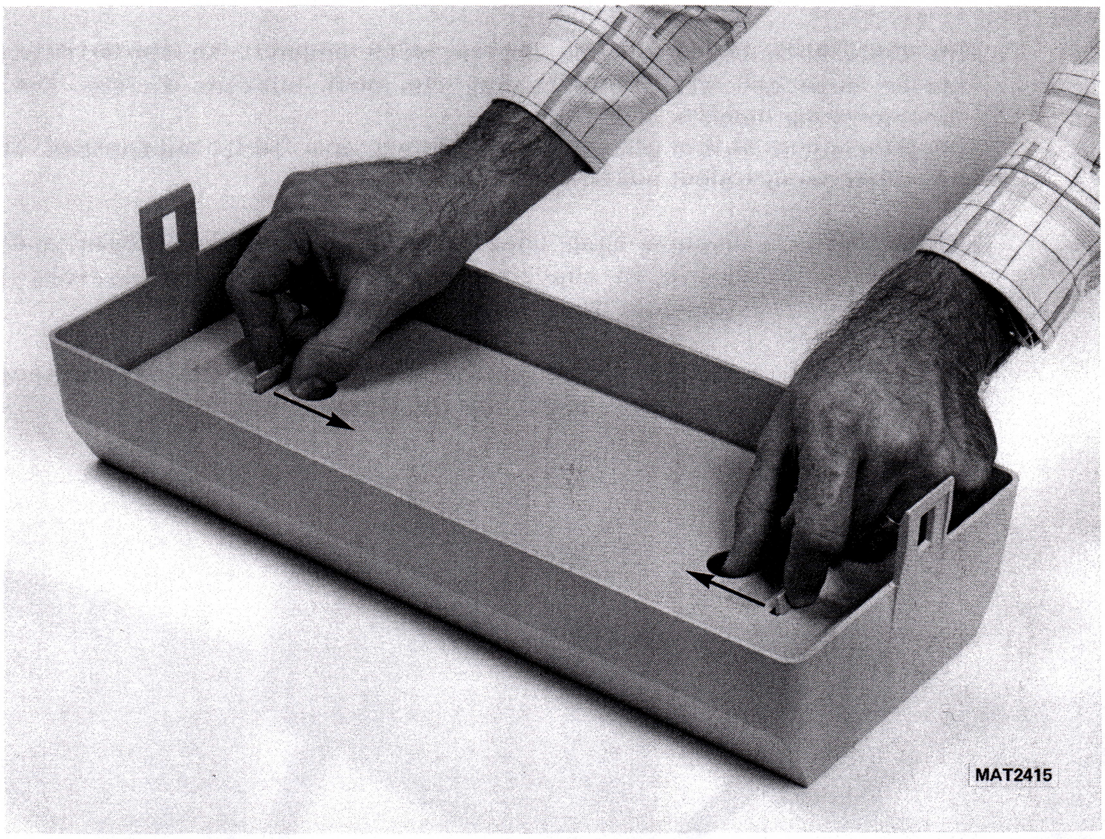


Figure 3.4 Removing the inner front cover. (storage space)

3.5 OPERATING POSITION OF THE INSTRUMENT

The oscilloscope may be used in the following positions:

- horizontally on its bottom feet;
- on the carrying handle in various sloping positions.

The available oscilloscope angles with respect to the working surface can be selected after depressing the push-buttons in the brackets of the carrying handle and turning.
The characteristics given in Chapter 6 are fully guaranteed for all the above-mentioned positions.

ATTENTION: Ensure that the fan hole in the rear cover and the holes in the cover are free from obstruction, for correct functioning of the fan.

Do not position the oscilloscope on any surface which radiates heat, or in direct sunlight.

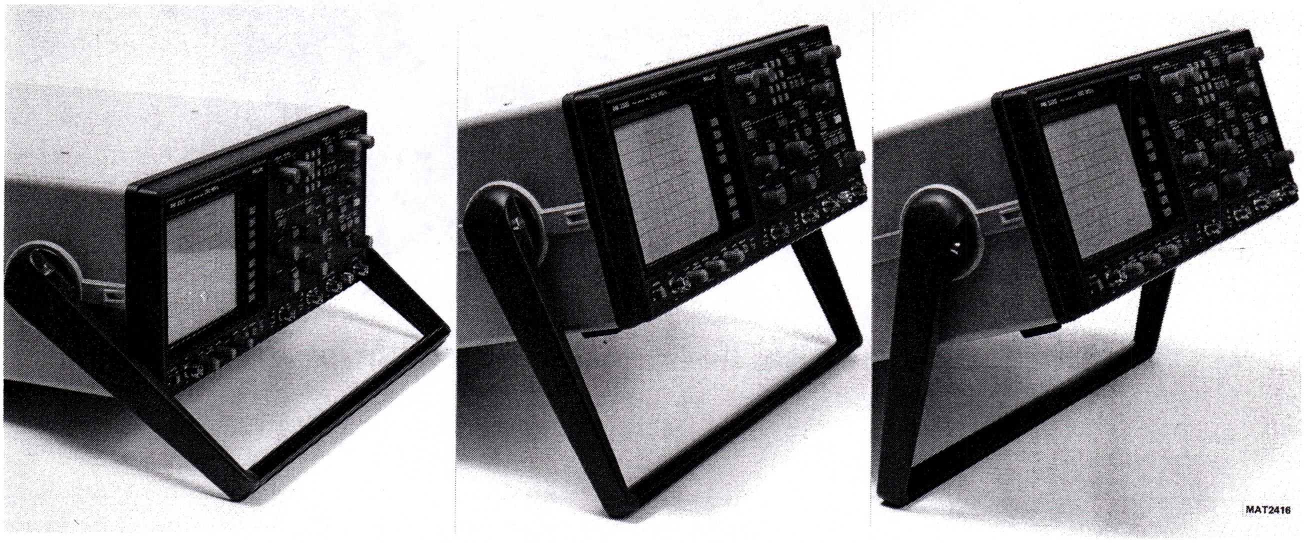


Figure 3.5 Carrying handle rotation and sloping positions.

3.6 IEEE 488/RS232-C INTERFACE OPTION PM 8956

If your oscilloscope is equipped with an option containing the IEEE 488 bus interface and an RS232-C interface, it can be used in an IEEE bus system configuration and in a system for serial communication.

For installation instructions, see information delivered with this option.

See also section 8.2 "OPTIONAL ACCESSORIES".

4.0 OPERATING INSTRUCTIONS

This chapter outlines the procedures and precautions necessary for operation. It identifies and briefly describes the functions of the front and rear panel controls and indicators, and explains the practical aspects of operation to enable an operator to evaluate quickly the instrument's main functions.

4.1 SWITCHING-ON AND POWER-UP ROUTINE

4.1.1 Switching-on

After the oscilloscope has been connected to the mains (line) voltage in accordance with Section 3.2.1. and 3.2.2. it can be switched on with the POWER ON/OFF switch on the front panel.
The associated POWER indicator lamp is adjacent to the POWER ON/OFF switch.

Having switched on the oscilloscope, a power-up routine is performed after which the instrument is ready for use.

With normal installation, according to Chapter 3, and after a warming-up time of 30 minutes, the characteristics according to Chapter 6 are valid.

4.1.2 Power-up routine

When switching-on the instrument, note that the internal microprocessor automatically starts a test for a number of internal circuits.

If during this test a circuit is found to be faulty, the test stops and this will be indicated as follows:

- the instrument fails to operate normally
- some, but not all of the indicator lamps light

If this occurs, it is recommended to switch off the instrument and switch on again after a few seconds.

IMPORTANT: If the fault condition persists, contact your local PHILIPS service department.

If the system blocks during operation, it may be due to extremely high static voltages. In this event, an automatical reset of the microprocessor system is performed and the operation of the instrument is restored.

4.1.3 Default settings after switching-on.

If no back up batteries are installed and the instrument is switched on, an automatic AUTO-SET action is performed.

With back up batteries installed, the instrument settings at the moment of switching off are restored and the instrument starts up with the same setting.

4.2 EXPLANATION OF CONTROLS AND SOCKETS

The controls and sockets are listed according to their functional sections and a brief description of each is given.

The next front panel view shows the controls and sockets, and the functional lay-out of the various sections.

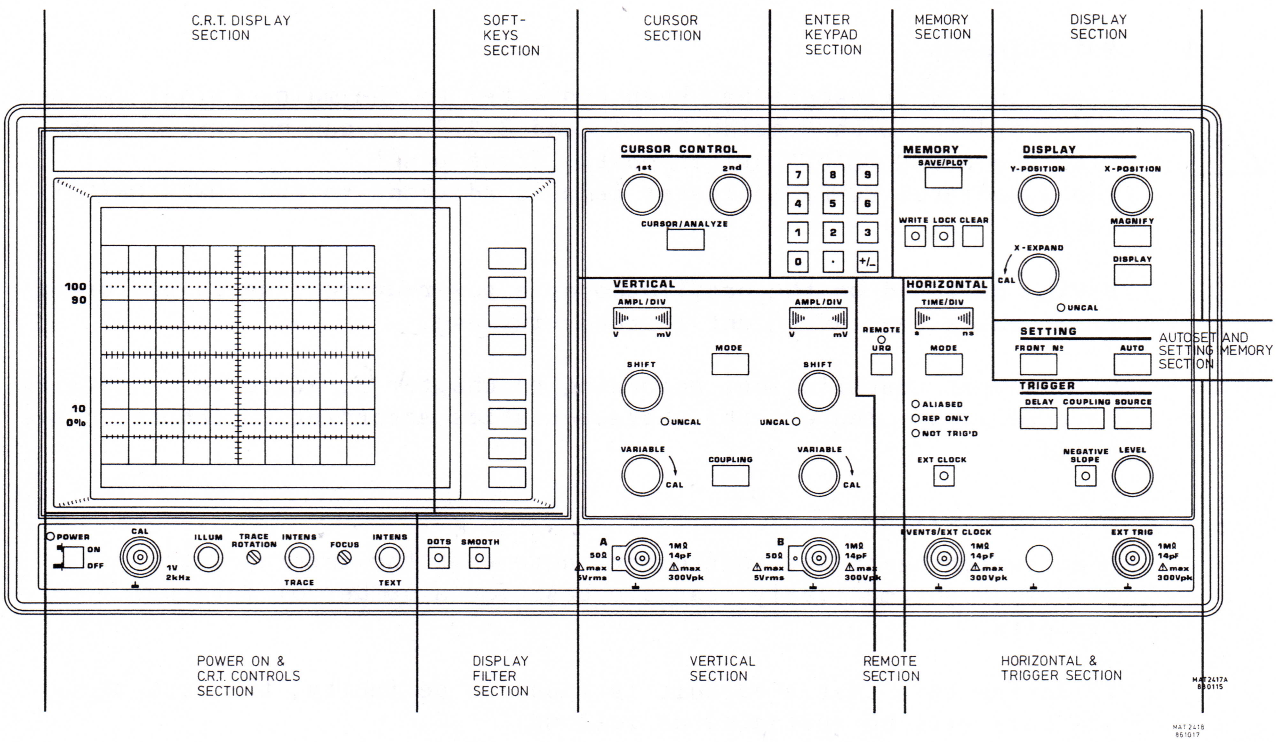


Figure 4.1 Front panel function lay-out.

Section:	See section:
SOFTKEYS SECTION	4.2.1
C.R.T. DISPLAY SECTION	4.2.2
AUTO SET SECTION	4.2.3
POWER ON & CRT CONTROLS SECTION	4.2.4
VERTICAL SECTION	4.2.5
HORIZONTAL SECTION	4.2.6
TRIGGER SECTION	4.2.7
CURSOR SECTION	4.2.8
MEMORY SECTION	4.2.9
DISPLAY SECTION	4.2.10
DISPLAY FILTER SECTION	4.2.10
SETTING MEMORY SECTION	4.2.11
ENTER KEYPAD SECTION	4.2.12
REMOTE SECTION	4.2.12

4.2.1 SOFTKEYS

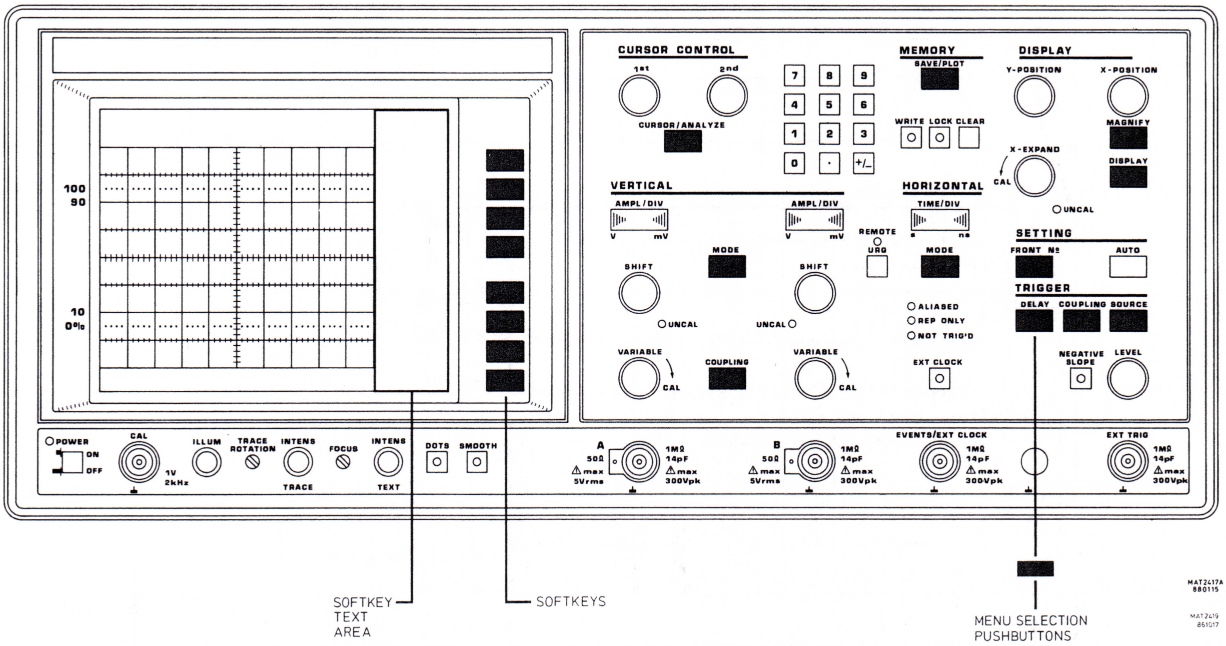


Figure 4.2 Front panel view.

Eight softkeys are located directly at the right side of the C.R.T. screen.
Different functions for these softkeys can be selected with the following eleven menu selection pushbuttons:

Front panel section:	See section:	Menu selection pushbutton:	See section:
VERTICAL	4.2.5	MODE	4.2.5.1
		COUPLING	4.2.5.2
HORIZONTAL	4.2.6	MODE	4.2.6.1
TRIGGER	4.2.7	DELAY	4.2.7.1
		COUPLING	4.2.7.2
		SOURCE	4.2.7.3
CURSOR (CONTROL)	4.2.8	CURSOR/ANALYZE	4.2.8.1
MEMORY	4.2.9	SAVE/PLOT	4.2.9.1
DISPLAY	4.2.10	MAGNIFY	4.2.10.1
		DISPLAY	4.2.10.2
SETTING	4.2.11	FRONT No	4.2.11

After depressing one of the above mentioned pushbuttons, the selected softkey menu is displayed in the softkey text area on the C.R.T. screen, directly at the left side of the softkeys.
In general the selected functions are intensified displayed in this softkey text area.

When for example the frontpanel pushbutton VERTICAL MODE is depressed, the following menu text will appear in the softkey text area.

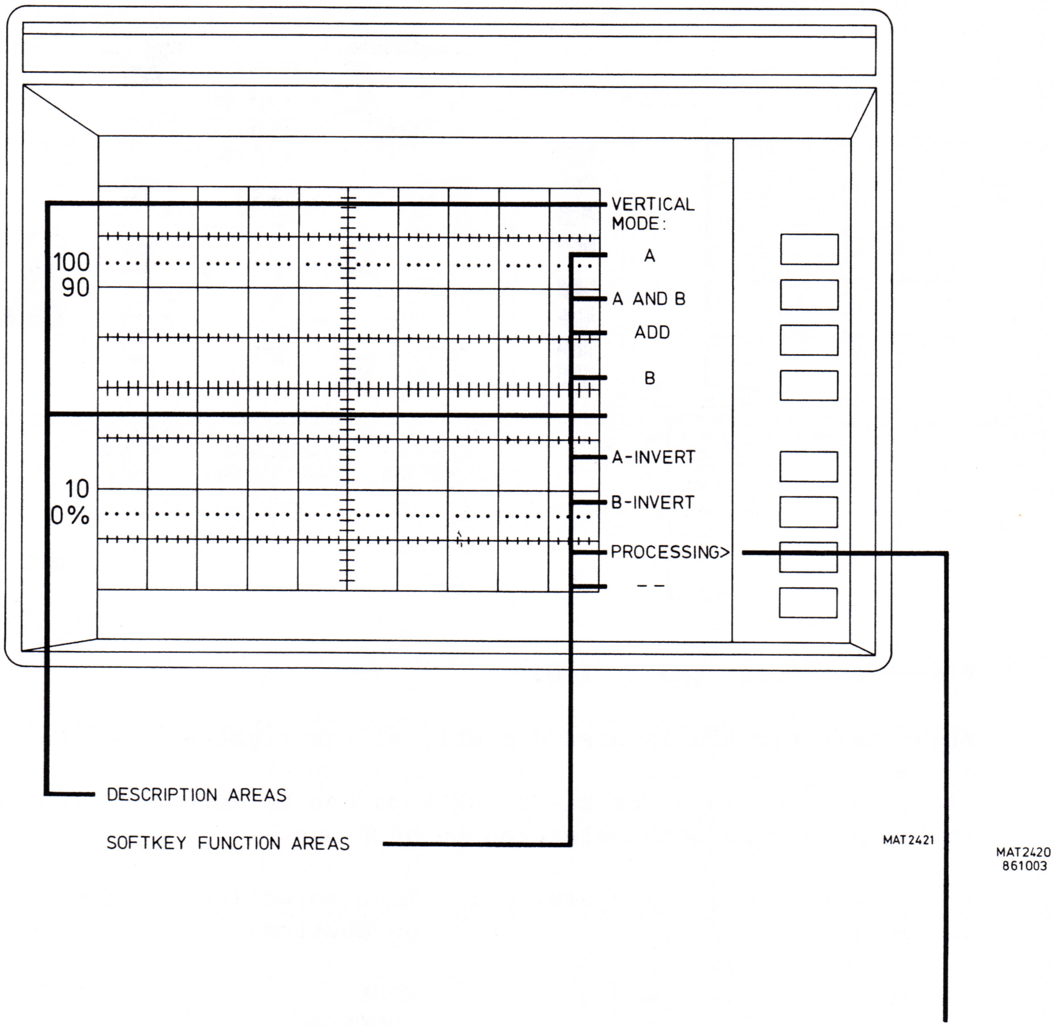


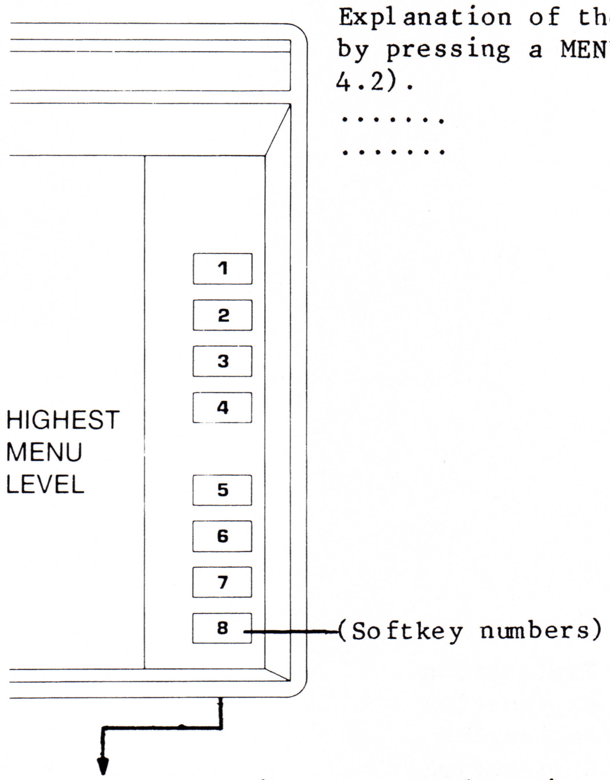
Figure 4.3 Example softkey text.

When the displayed softkey function is followed by a > , this indicates that the relevant softkey can be used to select the next lower function menu level.

RETURN: By depressing the softkey with the function RETURN (always the last softkey in the row of 8) a jump is made to the next higher function menu level.

EXECUTE: For some menu's a function EXECUTE is selectable which gives an automatic RETURN to the next higher function menu level after the EXECUTE action.

For the detailed explanation of the various menu structures the following explanation structure is used:

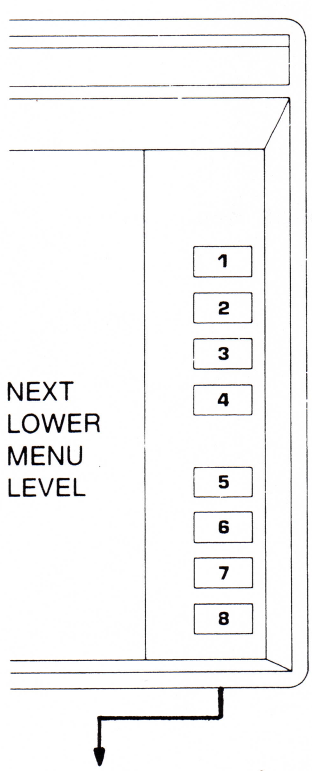


Explanation of the highest menu level which is selected by pressing a MENU SELECTION pushbutton (see figure 4.2).

....

....

1	Function	Explanation of the function behind softkey 1
2	Function	Explanation of the function behind softkey 2
3	Function	Explanation of the function behind softkey 3
4	Function>	(Jump to the next lower menu level)

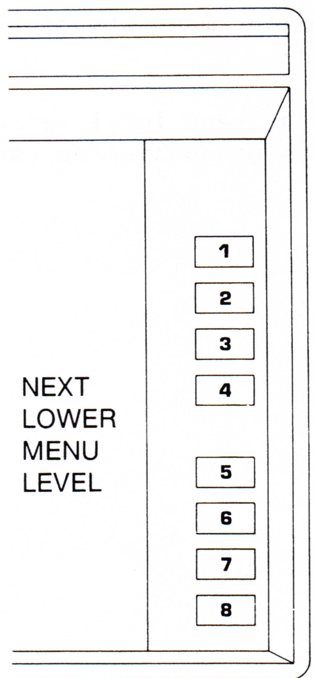


Explanation of the next lower menu level which in this example is selected by pressing softkey number four.

....

....

4	1	Function	Explanation of this function
4	2	Function	Explanation of this function
4	3	Function>	(Jump to the next lower menu level)



Explanation of the next lower menu level which in this example is selected by pressing softkey number three.

....

....

4	3	1	Function	Explanation
4	3	2	Function	Explanation
4	3	3	Function	Explanation
4	3	4	Function	Explanation
4	3	5	Function	Explanation
4	3	6	Function	Explanation
4	3	7	Function	Explanation
4	3	8	RETURN	Return to the next higher menu level

4	4	Function	Explanation
4	5	Function	Explanation
4	6	Function	Explanation
4	7	Function	Explanation
4	8	RETURN	Return to the highest menu level

5	Function
6	Function
7	Function
8	Function

Example:

If via the VERTICAL MODE menu the factor C=2 has to be selected for the AVERAGE mode, it can be done in the following way:

```
┌──────────────────────────── highest menu level
│    ┌─────────────────────── next lower menu level
│    │    ┌────────────────── next lower menu level
│    │    │
7    4    2    C=2        (see section 4.2.5.1)
```

- Press frontpanel pushbutton VERTICAL MODE

- Press softkey 7 function PROCESSING>

- Press softkey 4 function AVERAGE>

- Press softkey 2 function C=2

4.2.2 Screen lay-out and text areas

4.2.2.1 Screen lay-out an text areas when cursors are off.

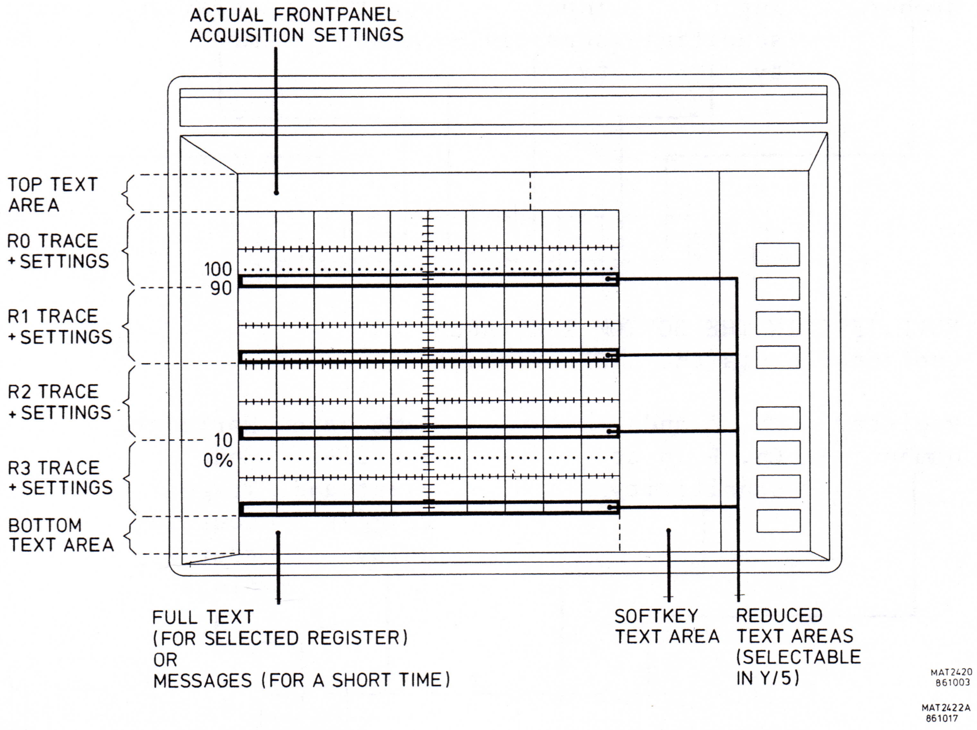
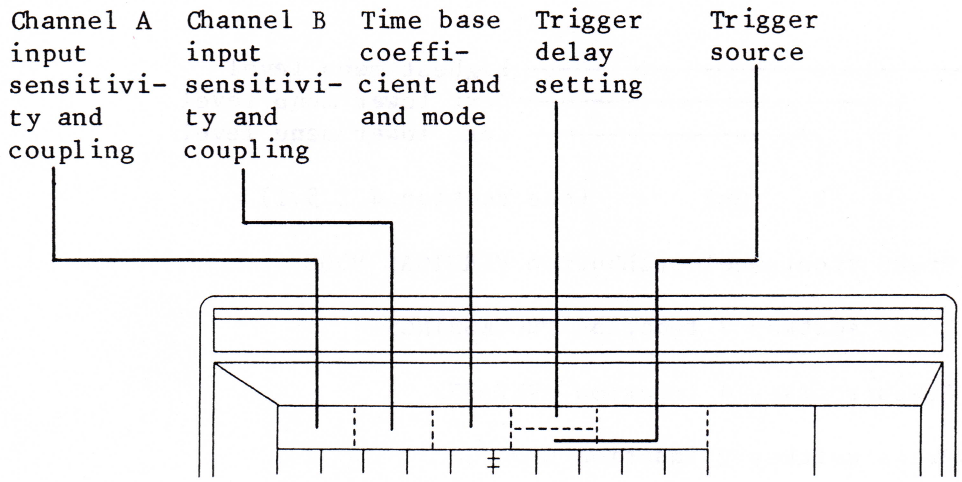


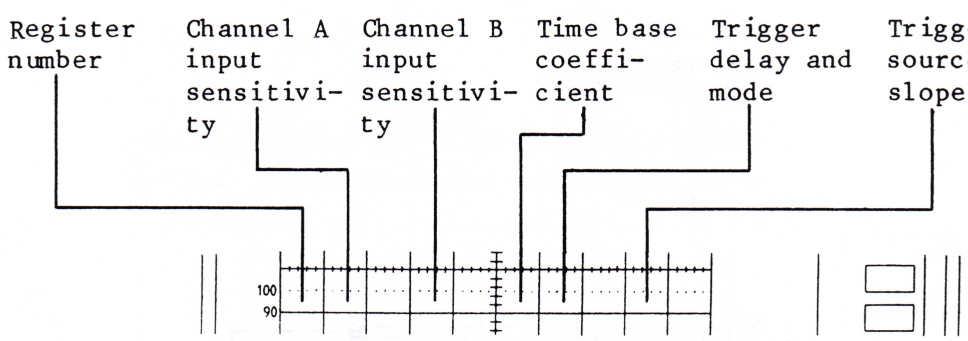
Figure 4.4 Screen lay-out.

Text areas:

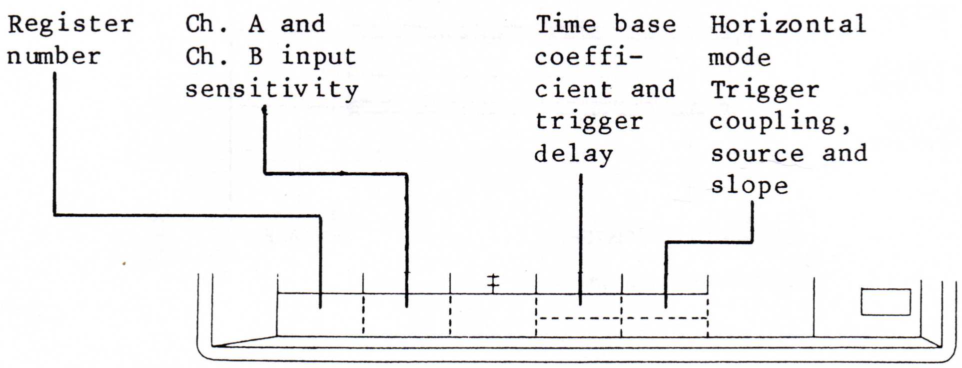
ACTUAL FRONT SETTINGS IN THE TOP TEXT AREA



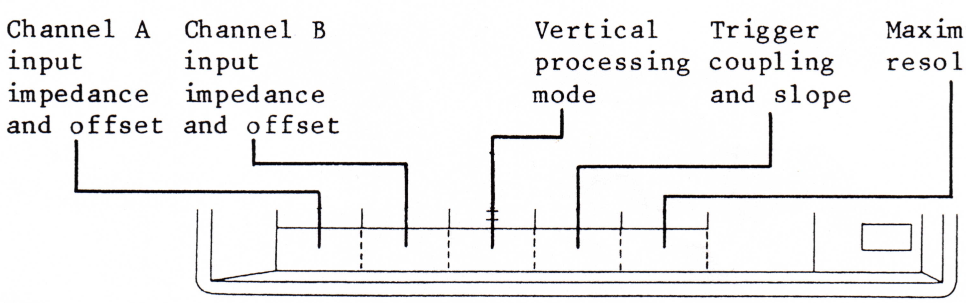
REDUCED TEXT IN THE TRACE AREA
(selectable via the DISPLAY menu if Y/5 is selected via the MAGNIFY menu)



FULL TEXT IN THE BOTTOM TEXT AREA
(selectable via the DISPLAY menu)



FRONT TEXT IN THE BOTTOM TEXT AREA
(selectable via the DISPLAY menu)



4.2.2.2 Screen lay-out and text areas when cursors are on.

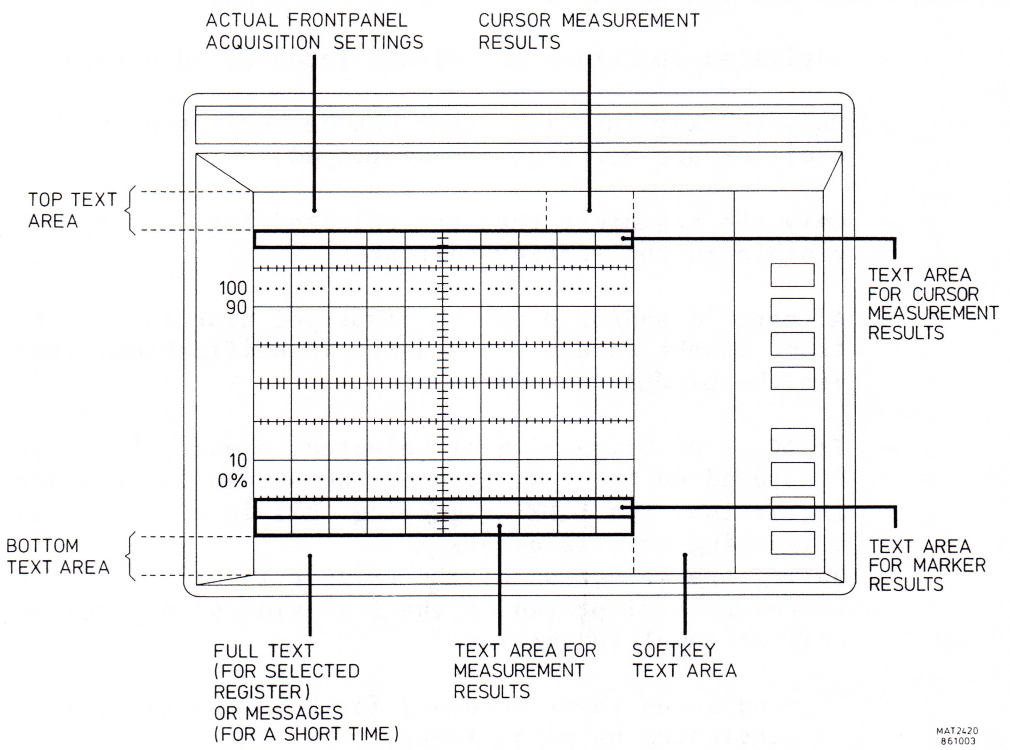
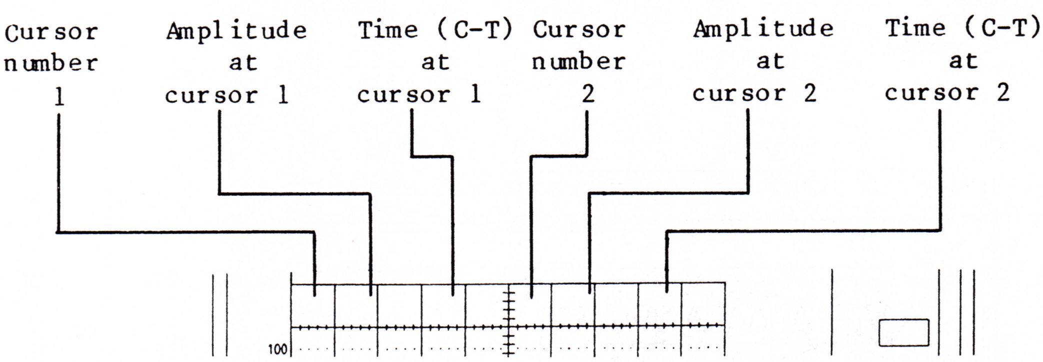


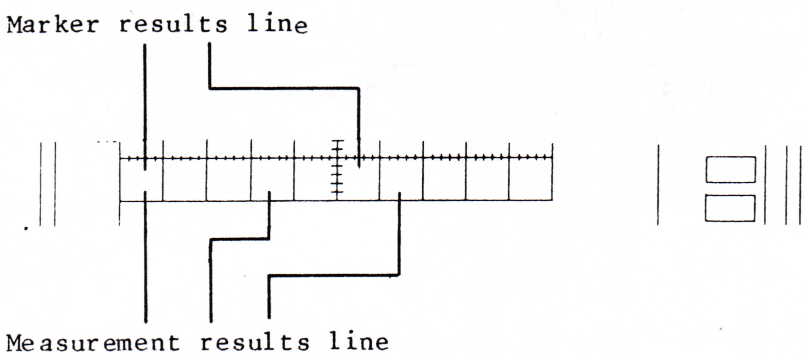
Figure 4.5 Screen lay-out.

TEXT AREA FOR CURSOR RESULTS



(Time (C-T) means time between Cursor and Trigger)

TEXT AREA FOR MEASUREMENT RESULTS



The measurement result line has a maximum of four results.
The amplitude measurement results are displayed first, seen from left to right.

4.2.2.3 General information about screen lay out and texts:

- Activated functions are always intensified displayed.
- Only softkey functions that can be activated in the actual oscilloscope setting, are displayed.
- Only the registers that are selected for display, are visible in the softkey text area.
- A letter A and/or B can be displayed near the start of each trace on the screen for channel identification. (selectable via the DISPLAY menu).
- If AC or DC triggering is selected, a mark ↑ , I or ↓ is displayed on the left side of the screen for trigger level indication. For LINE triggering this is a mark L and for EXT triggering this is a mark X.
  During the selection of the trigger level for EVENTS, a letter E is displayed on the left side of the screen for trigger level indication.
- ~ indicates lower accuracy for this function; is also indicated by pilot lamps
  / indicates positive trigger slope selection
  \ indicates negative trigger slope selection
  ⌃⌄ indicates MIN / MAX mode selection
  dts indicates that a number of dots is displayed.

Example:

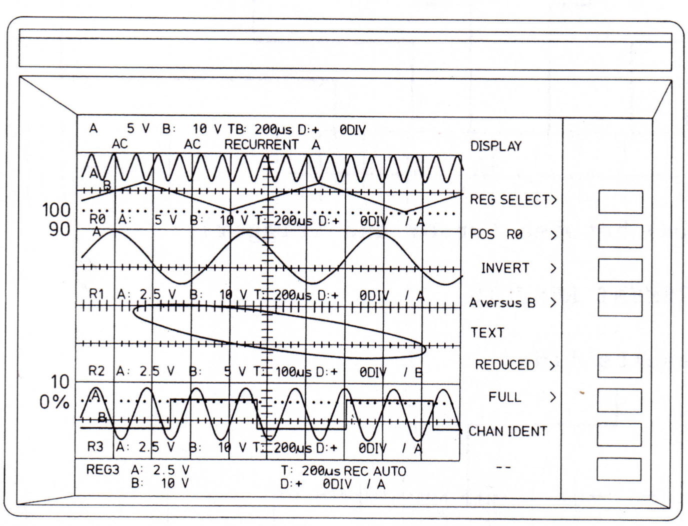


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Figure 4.6 Example screen lay-out when cursors off.

Example:

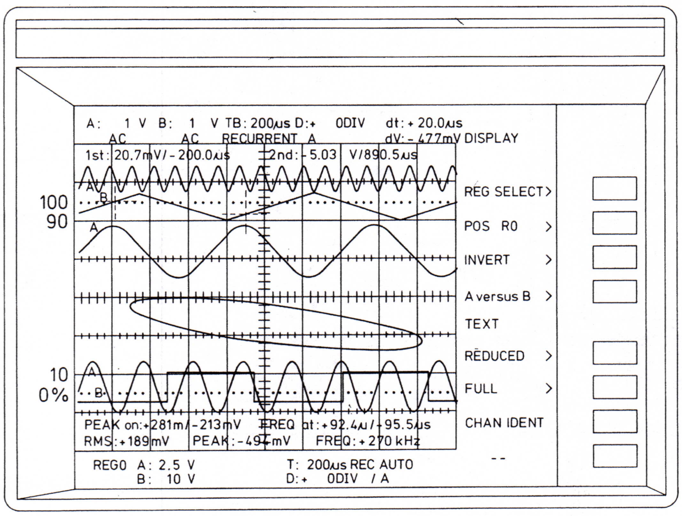

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Figure 4.7 Example screen lay-out when cursors and markers on.

4.2.3 AUTO-SET

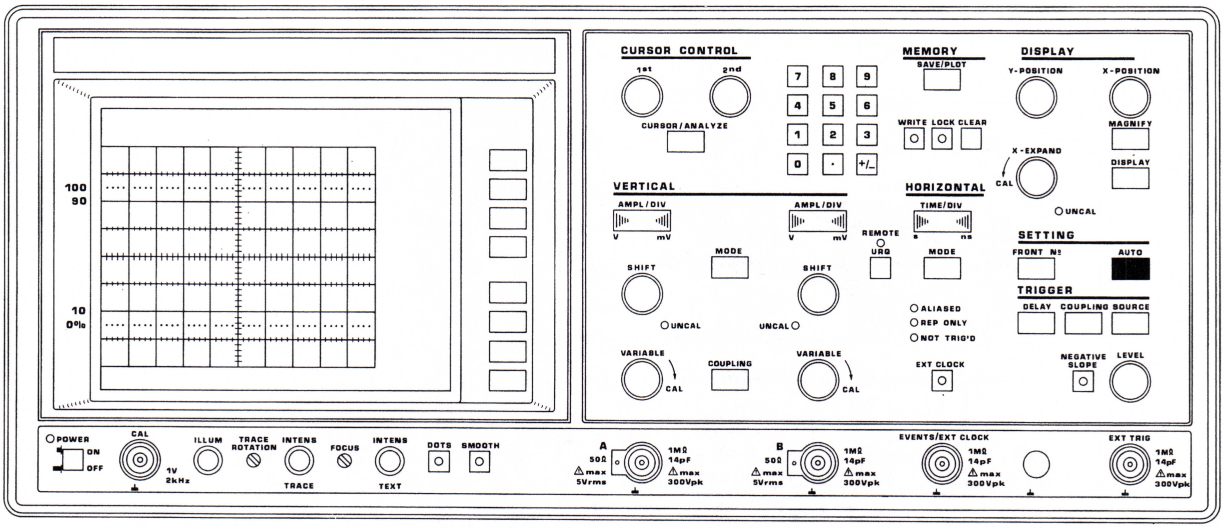
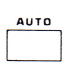


Figure 4.8 Front panel view.



If AUTO is pushed, a number of functions are preselected. Some of these functions are selected in relation to the applied input signals.

During the AUTO SET action, a message

* * * * * AUTO SET BUSY * * * * * *
* * * * * * * * * * * * * * * * *

is displayed.

Settings are such, that the contents of register R0 are displayed over the full C.R.T. screen.

The input signals will be displayed as triggered signals of a few periods and with an amplitude of a few divisions.

Details about AUTO SETTING are given in section 6.10 of the CHARACTERISTICS.

In LOCK mode a message

No AUTO SET possible in LOCK mode.

is displayed.

4.2.4. CRT section

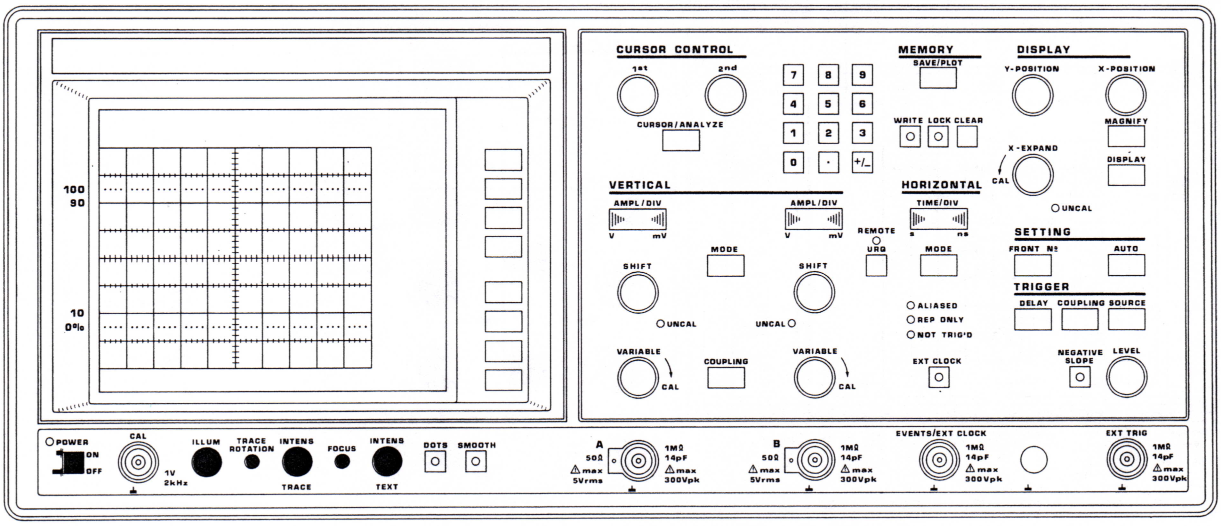
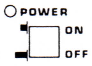


Figure 4.9 Front panel view.



POWER ON/OFF switch

After switching on the instrument, first an automatic power-up test is started (see also section 4.1).
The POWER ON LED indicates when the instrument is switched-on.

Continuously-variable control of the graticule illumination.

Screwdriver control for aligning the trace in parallel with the horizontal graticule lines.

Continuously-variable control of the trace brilliance on the C.R.T. screen.

Screwdriver control for the focussing of the C.R.T. electron beam (including the C.R.T. text).

Continuously-variable control of the brilliance of the C.R.T. text (control settings, cursors, softkey functions and messages).

4.2.5. VERTICAL SECTION AND MENU STRUCTURE

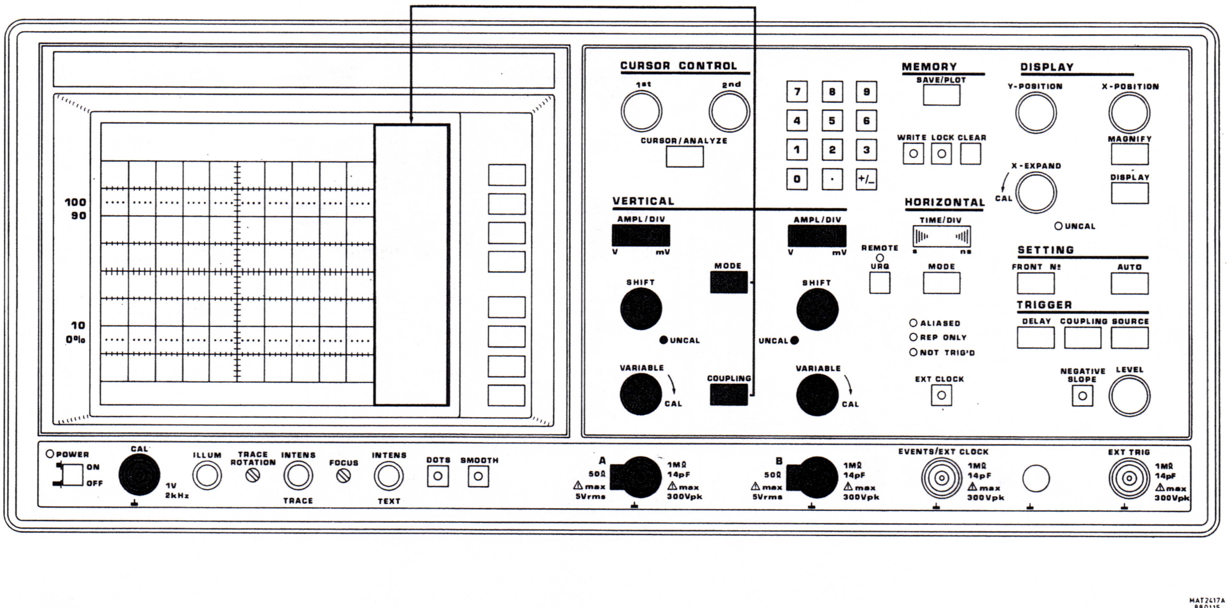
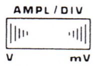
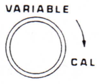


Figure 4.10. Front panel view.



This UP/DOWN control permits selection of the vertical deflection coefficients of the relevant channel in 10 steps from 5 mV/div...5 V/div in a 1-2-5 sequence.
The selected vertical deflection coefficient for the relevant channel is displayed in the top text area of the C.R.T. screen.

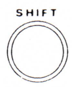
If the left side of the UP/DOWN control (V) is pushed, the amplitude of the signal on the screen decreases. This means that the AMPL/DIV value becomes bigger (e.g. the attenuator jumps from 2 V/div to 5 V/div).
If the right side of the UP/DOWN control (mV) is pushed, the amplitude of the signal on the screen increases. This means that the AMPL/DIV value becomes smaller (e.g. the attenuator jumps for 5 V/div to 2 V/div)



Continuously variable control of the deflection coefficients of the relevant channel. The deflection coefficients of the relevant channel are only calibrated when this control is set fully clockwise (UNCAL LED is off). In the UNCAL position, the vertical sensitivity decreases. The complete sensitivity range between two AMPL/DIV settings is adjustable.

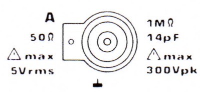
The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.

Pilot lamp indicating lower accuracy for the relevant vertical deflection coefficients.
If the VARIABLE control of the relevant channel is turned fully clockwise, the UNCAL pilot lamp is switched off.

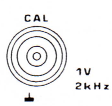


Continuously variable control giving vertical input shift of the trace of the relevant channel. This shift is introduced behind the attenuator but before the memory.

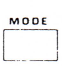
The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.



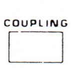
BNC input socket for the channel with probe indication detector.



BNC output socket for a square-wave calibration signal with an amplitude of 1 Vp-p and a frequency of 2 kHz.
The output voltage is reduced by a half when the output is terminated in 50 ohm.
When the output is short-circuited, the output current is 20 mA p-p (reduced by a half when terminated in 50 ohm).
The zero line of the square-wave signal is on the base-line level.



If pushbutton MODE is pushed, the VERTICAL MODE menu is displayed. See 4.2.5.1.



If pushbutton COUPLING is pushed, the VERTICAL COUPLING menu is displayed. See 4.2.5.2.

4.2.5.1. VERTICAL MODE MENU STRUCTURE

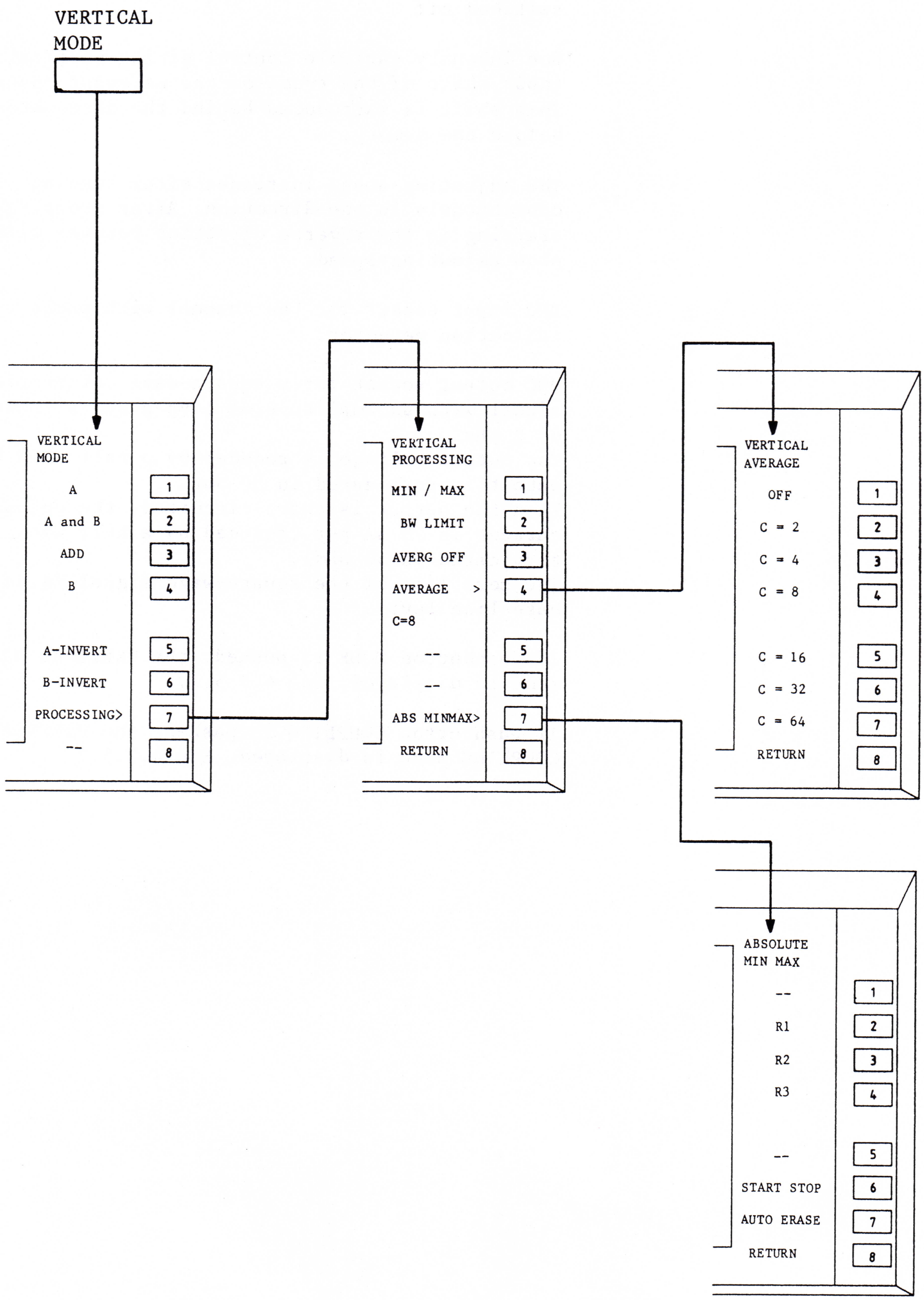
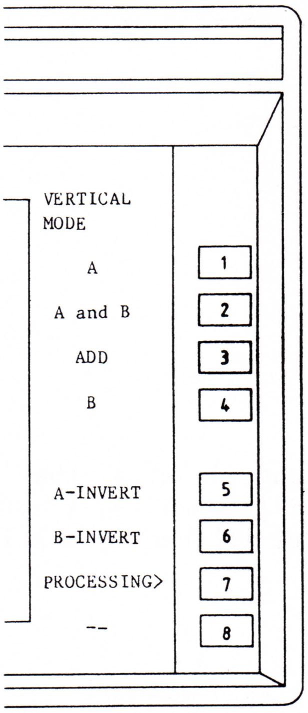


Figure 4.11 Vertical mode menu structure.

VERTICAL MODE MENU



After selection of the VERTICAL MODE menu by depressing pushbutton VERTICAL MODE, various modes related to the signal acquisition can be selected.

1 A

Pushing softkey A gives signal input from channel A only, indicated by an intensified text A.
If softkey A is pushed and function A and B was operative, in A versus B - mode a message will be displayed with the text

No A versus B possible with one channel only.
A versus B is switched off.

and channel A will be selected.

2 A and B

Pushing softkey A and B gives signal input from both channels A and B, indicated by an intensified text A and B.

3 ADD

Pushing softkey ADD gives signal input from channel A and channel B and the algebraic sum of A and B is recorded in the memory, indicated by an intensified text ADD.
If softkey ADD is pushed and A and B was operative, in A versus B -mode a message will be displayed with the text

No A versus B possible with one channel only.
A versus B is switched off.

and ADD will be selected.

4 B

Pushing softkey B gives signal input from channel B only, indicated by an intensified text B.
If softkey B is pushed and A and B was operative, in A versus B - mode a message will be displayed with the text

No A versus B possible with one channel only.
A versus B is switched off.

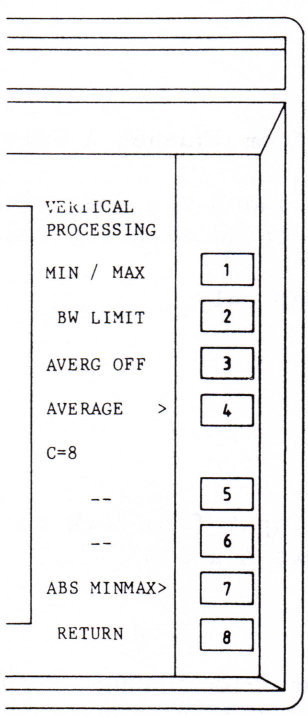
and channel B will be selected.

5 A-INVERT

6 B-INVERT

After pushing the relevant INVERT softkey the signal of the relevant channel is inverted before it is digitized and recorded in the memory. The text A-INVERT or B-INVERT is then intensified displayed.

7 PROCESSING>



After selecting PROCESSING>, the VERTICAL PROCESSING menu is displayed and input signal processing can be selected.

The text MIN / MAX is not visible in the time base positions faster than 5 us/div.

The text AVERG OFF is only visible if average is selected.

7 1 MIN / MAX

After pushing softkey MIN / MAX, two peak detectors are operative for each channel.
Glitches in the A channel as well as in the B channel can be catched at the same moment, since samples for both channels are taken at the same moment.
When switching from 5 us/div to 2 us/div with MIN / MAX on the MIN / MAX limitation is indicated by a message

No MIN / MAX possible when time base faster than
5 us/div. MIN / MAX switched off.

When switching from 2 us/div to 5 us/div and MIN / MAX on, the following message is displayed

Previous MIN / MAX setting restored.

- Glitches longer than 3 ns are detected with an accuracy of more than 50 %.
- Glitches shorter than 20 ns are not detected if occurring during the reset time of the peak detectors.
- MIN / MAX is not possible in combination with the AVERAGE function.
  If MIN / MAX is selected when AVERAGE is active, a message

  MIN / MAX and AVERAGE not possible.
  MIN / MAX on, AVERAGE off.

  is displayed.

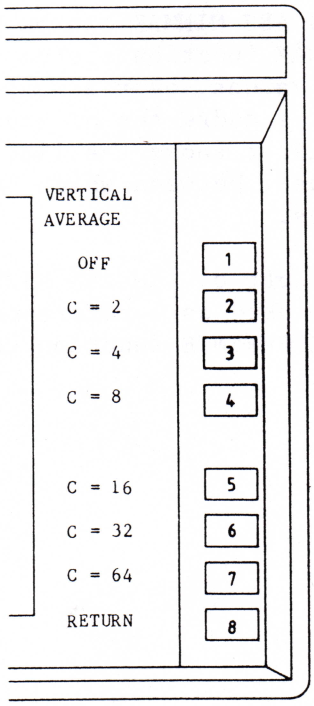
7 2 BW LIMIT

After pushing softkey BW LIMIT a bandwidth filter is active. This is indicated by an intensified text BW LIMIT. The bandwidth is 3 dB down at 20 MHz, using a 6 dB/octave filter. The filter is active in both channels.

7 3 AVERG OFF

After pushing softkey AVERG OFF, AVERAGE is switched off. This function is only displayed when AVERAGE is selected.

7 4 AVERAGE>



After selecting AVERAGE, the VERTICAL AVERAGE menu is displayed and the average function can be selected. (See also section 4.3.12). As long as average is operative, this is indicated by an intensified text C= .. in the VERTICAL PROCESSING menu.
If AVERAGE is not operative, it is indicated by an intensified text C=OFF in the VERTICAL PROCESSING menu.
AVERAGE is not possible in combination with the MIN / MAX function.
If AVERAGE is selected when MIN / MAX is active, a message

AVERAGE and MIN / MAX not possible.
AVERAGE on, MIN / MAX off.

is displayed.

7 4 1 OFF

Softkey OFF must be pushed to switch the AVERAGE function off.

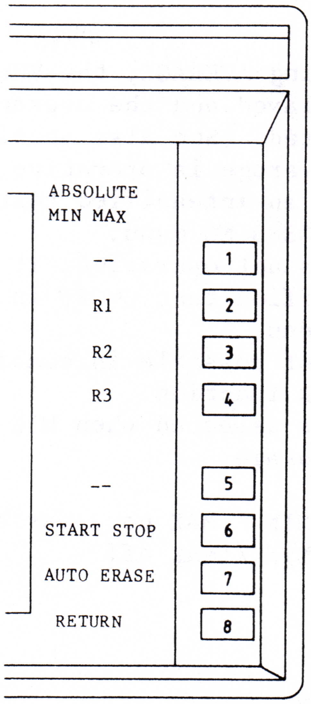
7	4	2	C=2
7	4	3	C=4
7	4	4	C=8
7	4	5	C=16
7	4	6	C=32
7	4	7	C=64

Different calculation constants between C=2 and C=64 can be selected.
The bigger the value of C is, the stronger the AVERAGE effect is.
For more detailed information see 4.3.12.

7	4	8	RETURN

After pushing softkey RETURN, the VERTICAL PROCESSING menu is displayed again and the average selection (the value of C) remains as selected before.

7	5	--
7	6	--
7	7	ABS MINMAX



After selecting ABS MINMAX, the ABSOLUTE MIN MAX menu is displayed, the parameters can be selected and ABS MINMAX can be started.
The ABS MINMAX function stores, the minimum and maximum values, over a number of scans, on alternating addresses of each channel. So, the register shows the limits in a vertical sense, between which the input signal varies.

Note: The result of the ABS MINMAX function can be used as a reference signal for the DIFFERENCE function (see section 4.2.6).

7 7 1 --

7 7 2 R1

7 7 3 R2

7 7 4 R3

With these softkeys the register can be selected in which the result of the ABS MIN MAX function is stored.

7 7 5 --

7 7 6 START STOP

The ABS MINMAX function can be activated or stopped with this softkey. The actual situation is displayed intensified.

7 7 7 AUTO ERASE

The AUTO ERASE function clears the result of the ABS MINMAX function in the selected register after 10 seconds or after 100 scans, depending on whichever comes last.
If the function is active, the function is displayed intensified. Pushing the softkey again switches the function off.

7 7 8 RETURN

After pushing softkey RETURN, the VERTICAL PROCESSING menu is displayed again.

7 8 RETURN

After pushing RETURN, the VERTICAL MODE menu is displayed again and the selections previously selected remain.

8 --

4.2.5.2. VERTICAL COUPLING MENU STRUCTURE

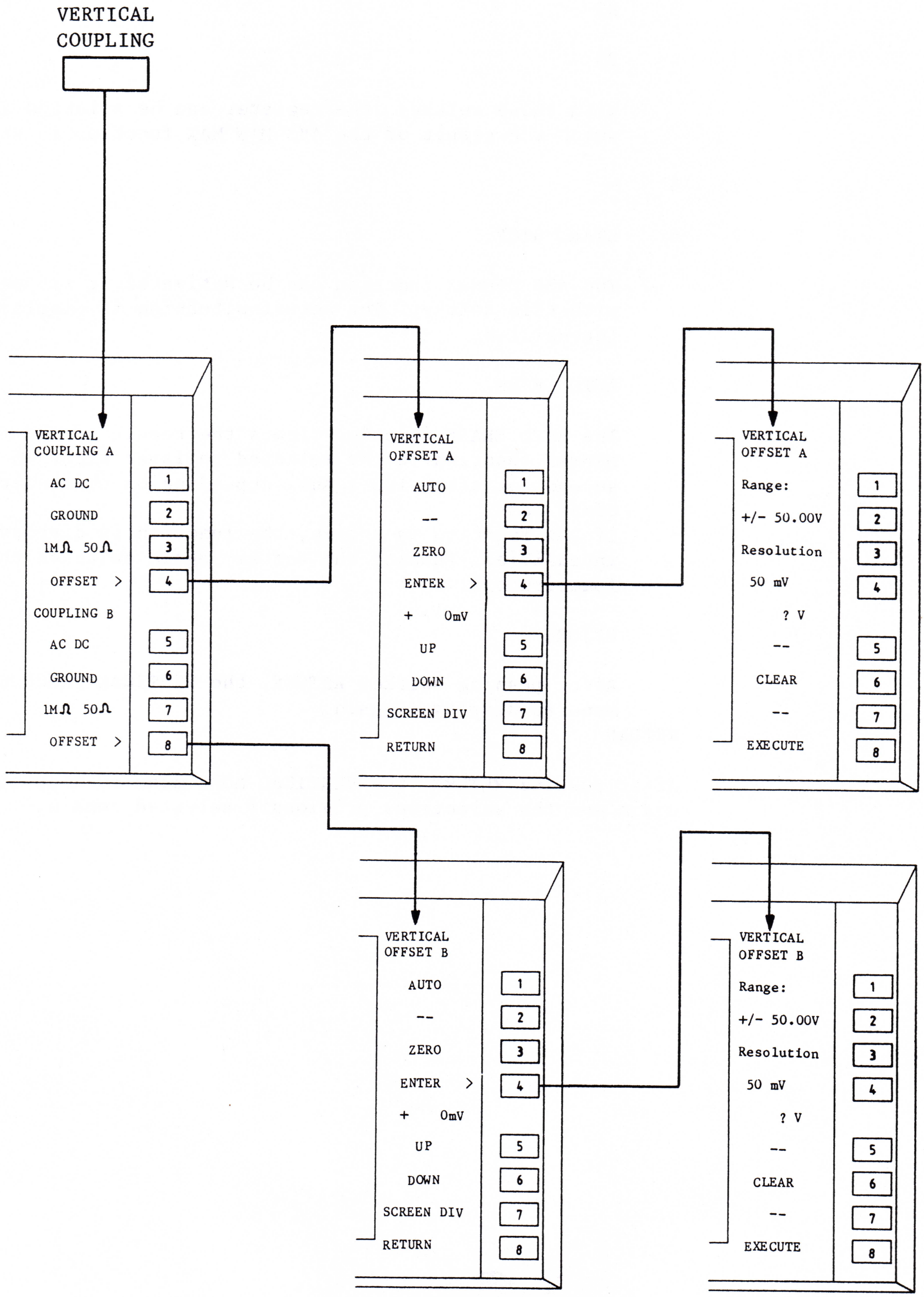
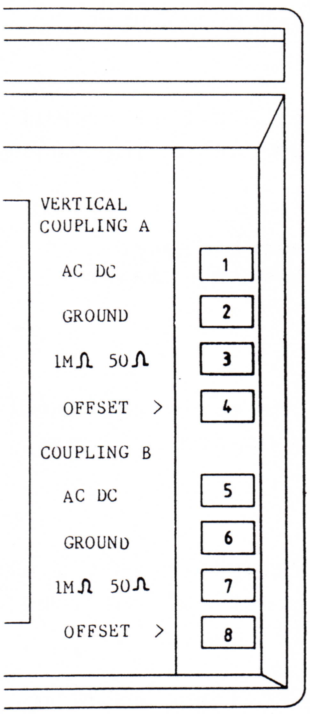


Figure 4.12 Vertical coupling menu structure.

VERTICAL COUPLING MENU



After pressing pushbutton VERTICAL COUPLING, the VERTICAL COUPLING menu for channel A and channel B is displayed and the input coupling for these channels can be selected.

1 AC DC (channel A)

With this softkey a selection can be made between AC input coupling and DC input coupling. Pushing this softkey changes the selection from AC to DC or reverse, the active selection is displayed intensified.
If AC is selected, the offset becomes 0 Volt.
If DC is selected, the previously selected offset value is active again.

2 GROUND (channel A)

With GROUND selected, the connection between the input socket and the relevant input circuit is interrupted and the input circuit is grounded.

3 1 MOhm 50 Ohm (channel A)

With this softkey, a selection can be made between an input impedance of 1 MOhm or an input impedance of 50 Ohm.

If a probe with automatic probe indication is used, the oscilloscope automatically switches to the correct impedance. No other selection can be made then.

If an input voltage higher than 5 V dc and ac r.m.s. is applied to the input socket and 50 Ohm is selected, the instrument does not switch to 50 Ohm and a message

Unsafe condition for 50 Ohm to be switched on.
Input impedance not changed.

is displayed.

If 50 Ohm is on and an input voltage between 5 V dc and ac r.m.s. and 25 V dc and ac r.m.s. is applied to the input socket, the instrument will automatically switch to 1 MOhm input impedance (without warning).

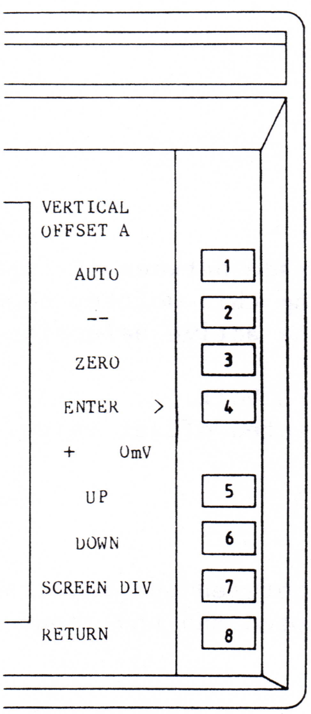
If 50 Ohm is on and an input voltage higher than 25 V dc and ac r.m.s. is applied to the input socket; 50 Ohm input impedance will not be switched off and the message

OVERLOAD ON CHANNEL A: reduce signal to prevent damages.
****

is displayed.

IMPORTANT: Remove the input voltage or decrease the input voltage immediately to $\leq$ 5 V dc and ac r.m.s.!

4 OFFSET> (channel A)



If OFFSET is selected the VERTICAL/OFFSET A menu is displayed and an offset (vertical shift before attenuator) value can be selected.

OFFSET is only effective if DC input coupling is selected.

If OFFSET is selected and AC coupling is active, the displayed OFFSET is not effective. If the OFFSET is changed, a message

OFFSET only possible if channel is DC- coupled.
AC is switched to DC.

is displayed and the input coupling is automatically switched to DC.

If a probe with automatic range indication is used, the offset voltage is automatically adapted.

4 1 AUTO

With softkey AUTO, the offset value is set to such a level, that the mid-value of the input signal is shifted as much as possible to mid-memory.

A message

* * * AUTO OFFSET FOR CHANNEL A * * *
* * * * * * * * * * * * * * * * * *

is displayed.

The new offset value is displayed in the softkey text area. The VERTICAL SHIFT is set to zero.

A message

AUTO OFFSET error : signal offset out of range.

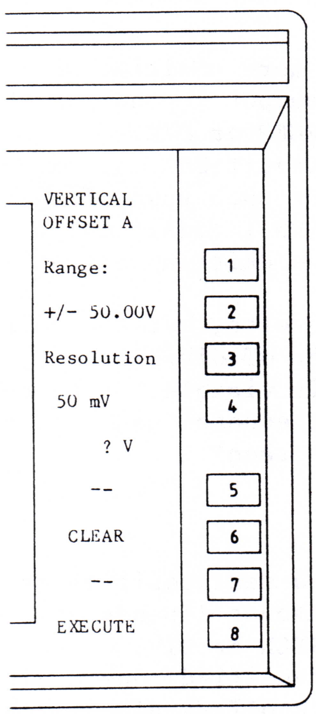
is displayed if the input signal is exceeding the offset control range. In this case the original offset value is restored.

4 2 --

4 3 ZERO

With softkey ZERO, the offset value is set to zero.

4 4 ENTER>



After selecting ENTER, the ENTER menu will be displayed and the offset can be selected with the numeric keypad.
The range in Volts, which is related to the actual AMPL/DIV setting, is indicated and the selected value is rounded off and made visible in the softkey text area.

A message

Too many digits: total entry is cleared.

can be displayed if too many digits are entered on the numeric keyboard.

4 4 1 --

4 4 2 --

4 4 3 --

4 4 4 --

4 4 5 --

4 4 6 CLEAR

If an error is made, the selected offset value can be cleared after pushing softkey CLEAR.

4 4 7 --

4 4 8 EXECUTE

After pushing this softkey, the selected offset value is entered and an AUTO RETURN is performed to menu VERTICAL OFFSET A.
If EXECUTE is pressed after CLEAR the previous value remains (in the VERTICAL OFFSET A menu).

A message

A- OFFSET out of range.

can be displayed if the entered value exceeds the given range.

4 5 UP

Pushing softkey UP gives a more positive or less negative offset to the signal. The amount depends on the attenuator setting and the setting SCREEN or DIV.
If DIV is selected (DIV intensified) one division is added to the existing offset after each push of the UP softkey.
If SCREEN is selected (SCREEN intensified) a full screen of 10 divisions is added to the existing offset after each push of the UP softkey.
The result is displayed in volts, but the voltage is recalculated from the number of divisions.
For example: when 1.005 V is visible, it becomes 1.025 V, then 1.045 V etc. if the attenuator has been set to 20 mV/div (200 mV for a full screen).

4 6 DOWN

Pushing softkey DOWN gives a less positive or more negative offset to the signal. The amount depends on the attenuator setting and the setting SCREEN or DIV.
If DIV is selected (DIV intensified) one division is subtracted from the existing offset after each push of the DOWN softkey.
If SCREEN is selected (SCREEN intensified) a full screen of 10 divisions is subtracted from the existing offset after each push of the DOWN softkey.
The result is displayed in volts, but the voltage is recalculated from the number of divisions.
For example: when 1.005 V is visible, it becomes 985 mV, then 965 mV etc. if the attenuator has been set to 20 mV/div. (200 mV for a full screen).

4 7 SCREEN DIV

With this softkey, a selection can be made between an offset change in divisions or in screens (10 divisions) when the softkeys UP or DOWN are operated.
Pushing this softkey changes the selection from SCREEN to DIV or reverse. The active selection is displayed intensified.

4 8 RETURN

After pushing softkey RETURN, menu VERTICAL COUPLING A is displayed again.
The selections as made before remain.

5 AC DC (channel B)

With this softkey a selection can be made between AC input coupling and DC input coupling. Pushing this softkey changes the selection from AC to DC or reverse, the active selection is displayed intensified.
If AC is selected, the offset becomes 0 Volt.
If DC is selected, the previously selected offset value is active again.

6 GROUND (channel B)

With GROUND selected, the connection between the input socket and the relevant input circuit is interrupted and the input circuit is grounded.

7 1 MOhm 50 Ohm (channel B)

With this softkey, a selection can be made between an input impedance of 1 MOhm or an input impedance of 50 Ohm.

If a probe with automatic probe indication is used, the oscilloscope automatically switches to the correct impedance. No other selection can be made then.

If an input voltage higher than 5 V dc and ac r.m.s. is applied to the input socket and 50 Ohm is selected, the instrument does not switch to 50 Ohm and a message

Unsafe condition for 50 Ohm to be switched on.
Input impedance not changed.

is displayed.

If 50 Ohm is on and an input voltage between 5 V dc and ac r.m.s. and 25 V dc and ac r.m.s. is applied to the input socket, the instrument will automatically switch to 1 MOhm input impedance (without warning).

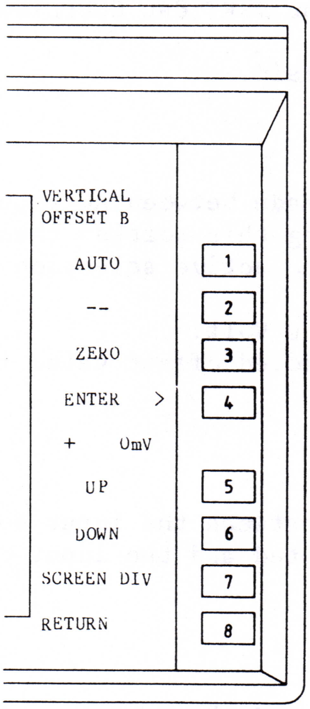
If 50 Ohm is on and an input voltage higher than 25 V dc and ac r.m.s. is applied to the input socket; 50 Ohm input impedance will <u>not</u> be switched off and the message

OVERLOAD ON CHANNEL B: reduce signal to prevent damages.
****

is displayed.

IMPORTANT: Remove the input voltage or decrease the input voltage immediately to $\leq$ 5 V dc and ac r.m.s.!

8 OFFSET> (channel B)



If OFFSET is selected the VERTICAL/OFFSET B menu is displayed and an offset (vertical shift before attenuator) value can be selected.

OFFSET is only effective if DC input coupling is selected.

If OFFSET is selected and AC coupling is active, the displayed OFFSET is not effective. If the OFFSET is changed, a message

OFFSET only possible if channel is DC- coupled.
AC is switched to DC.

is displayed and the input coupling is automatically switched to DC.

If a probe with automatic range indication is used, the offset voltage is automatically adapted.

8 1 AUTO

With softkey AUTO, the offset value is set to such a level, that the mid-value of the input signal is shifted as much as possible to mid-memory.

A message

* * * AUTO OFFSET FOR CHANNEL B * * *
* * * * * * * * * * * * * * * * * * *

is displayed.

The new offset value is displayed in the softkey text area. The VERTICAL SHIFT is set to zero.

A message

AUTO OFFSET error : signal offset out of range.

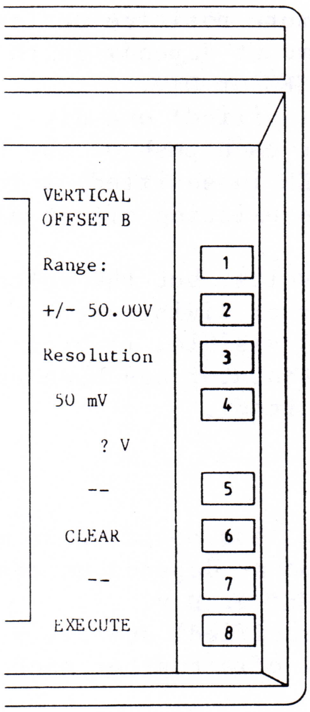
is displayed if the input signal is exceeding the offset control range. In this case the original offset value is restored.

8 2 --

8 3 ZERO

With softkey ZERO, the offset value is set to zero.

8 4 ENTER>



After selecting ENTER, the ENTER menu will be displayed and the offset can be selected with the numeric keypad.
The range, which is related to the actual AMPL/DIV setting, is indicated and the selected value is rounded off and made visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed, if too many digits are entered on the numeric keyboard.

8 4 1 --

8 4 2 --

8 4 3 --

8 4 4 --

8 4 5 --

8 4 6 CLEAR

If an error is made, the selected offset value can be cleared after pushing softkey CLEAR.

8 4 7 --

8 4 8 EXECUTE

After pushing this softkey, the selected offset value is entered and an AUTO RETURN is performed to menu VERTICAL OFFSET B.
If EXECUTE is pressed after CLEAR the previous value remains (in the VERTICAL OFFSET B menu).

A message

B- OFFSET out of range.

is displayed, if the entered value exceeds the given range.

8 5 UP

Pushing softkey UP gives a more positive or less negative offset to the signal. The amount depends on the attenuator setting and the setting SCREEN or DIV.
If DIV is selected (DIV intensified) one division is added to the existing offset after each push of the UP softkey.
If SCREEN is selected (SCREEN intensified) a full screen of 10 divisions is added to the existing offset after each push of the UP softkey.
The result is displayed in volts, but the voltage is recalculated from the number of divisions.
For example: when 1.005 V is visible, it becomes 1.025 V, then 1.045 V etc. if the attenuator has been set to 20 mV/div (200 mV for a full screen).

8 6 DOWN

Pushing softkey DOWN gives a less positive or more negative offset to the signal. The amount depends on the attenuator setting and the setting SCREEN or DIV.
If DIV is selected (DIV intensified) one division is subtracted from the existing offset after each push of the DOWN softkey.
If SCREEN is selected (SCREEN intensified) a full screen of 10 divisions is subtracted from the existing offset after each push of the DOWN softkey.
The result is displayed in volts, but the voltage is recalculated from the number of divisions.
For example: when 1.005 V is visible, it becomes 985 mV, then 965 mV etc. if the attenuator has been set to 20 mV/div. (200 mV for a full screen).

8 7 SCREEN DIV

With this softkey, a selection can be made between an offset change in divisions or in screens (10 divisions) when the softkeys UP or DOWN are operated.
Pushing this softkey changes the selection from SCREEN to DIV or reverse. The active selection is displayed intensified.

8 8 RETURN

After pushing softkey RETURN, menu VERTICAL COUPLING B is displayed again.
The selections as made before remain.

4.2.6. HORIZONTAL SECTION AND MENU STRUCTURE

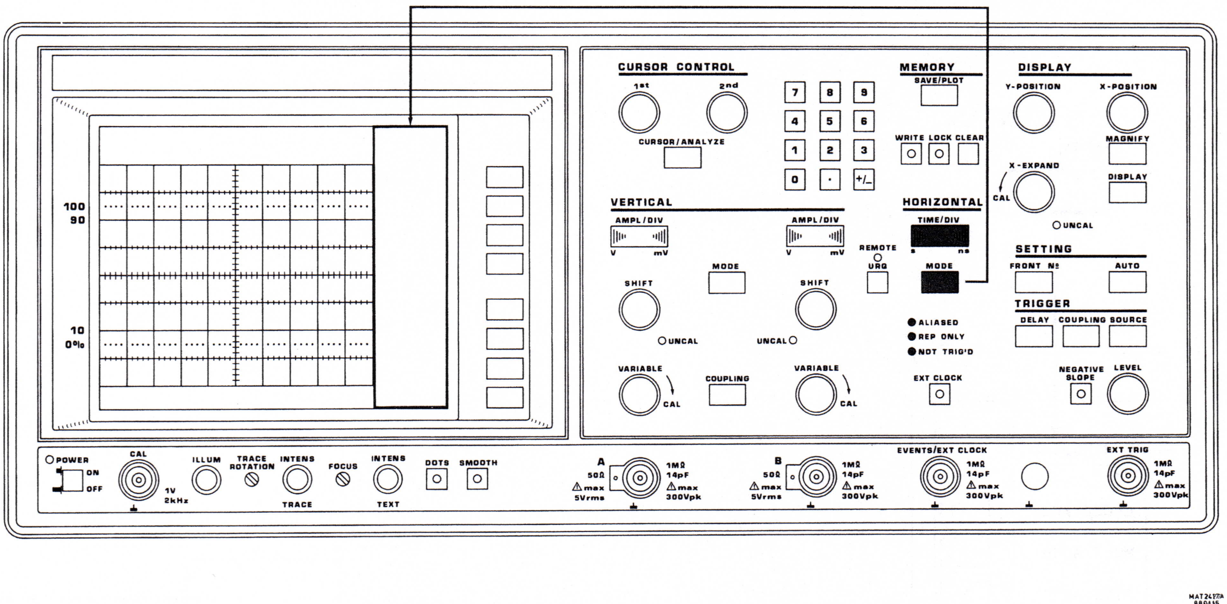
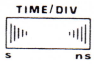


Figure 4.13 Front panel view.



This switch permits selection of the horizontal deflection coefficients of the time base in 28 steps from 5 ns/div ... 5 s/div. in a 1-2-5 sequence. In ROLL mode from 50 ms/div ... 360 s/div.

The selected horizontal deflection coefficient is displayed in the upper text area of the C.R.T. screen.

If the left side of the UP/DOWN control(s) is pushed more signal periods will be displayed. This means that the TIME/DIV value becomes bigger (e.g. the time-base jumps from 2 ms/div to 5 ms/div).
If the right side of the UP/DOWN control (ns) is pushed fewer signal periods will be displayed. This means that the TIME/DIV value becomes smaller (e.g. the time-base jumps from 5 ms/div to 2 ms/div).

O ALIASED

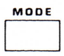
Pilot lamp indicating that aliasing is detected on the trigger channel.
If the pilot lamp is on, the wave form which is displayed on the screen does not represent the real shape of the input signal. See also 4.3.11.

O REP ONLY

Pilot lamp indicating that the digital time-base is set in the random sampling mode (100 ns/div. ... 5 ns/div.). In this case only signals with a repetitive character can be measured.

O NOT TRIG'D

Pilot lamp indicating that the oscilloscope is not triggered.



If pushbutton HORIZONTAL MODE is pushed, the HORIZONTAL MODE menu is displayed. See 4.2.6.1.

4.2.6.1. HORIZONTAL MODE MENU STRUCTURE

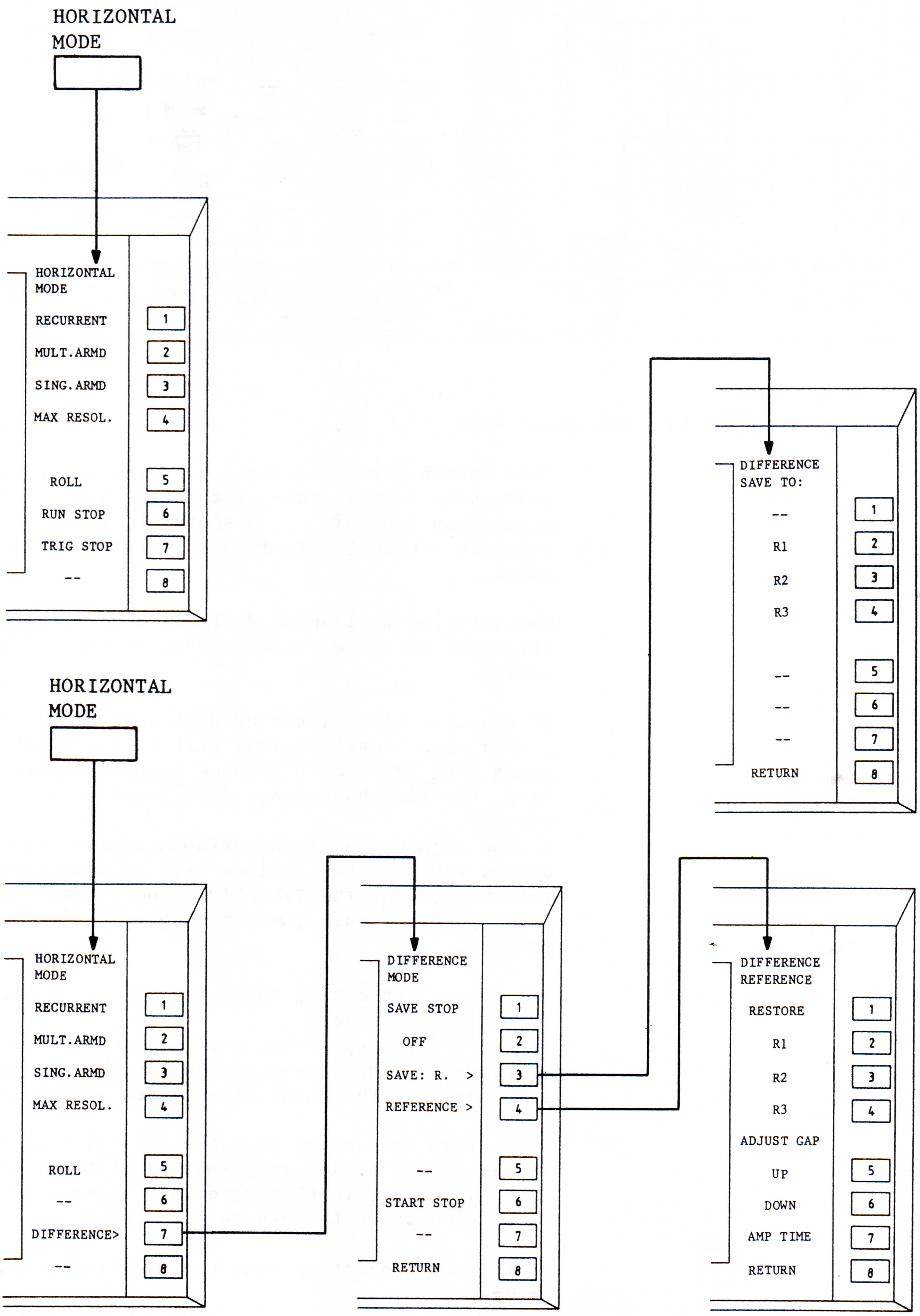
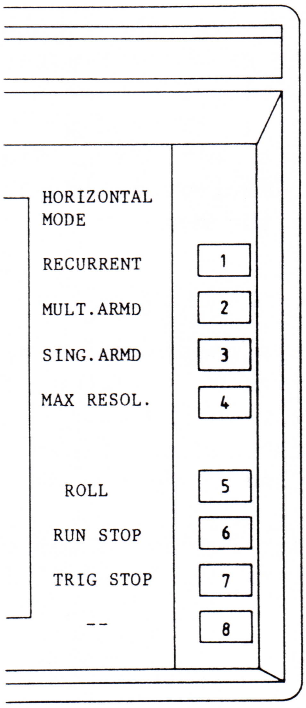


Figure 4.14 Horizontal mode menu structure.

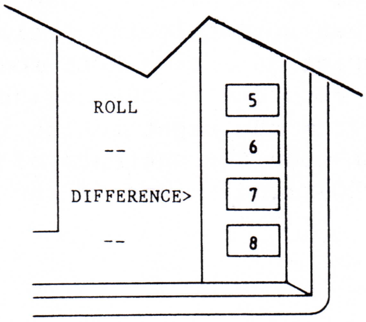
HORIZONTAL MODE MENU



After selection of the HORIZONTAL MODE menu by depressing pushbutton HORIZONTAL MODE, the required time-base mode can be selected.

The text MAX RESOL. is not visible in the MIN / MAX and in the AVERAGE mode.

When ROLL is selected, the text RUN STOP will appear for softkey 6 and the function at softkey 7 (DIFFERENCE) is replaced by TRIG.STOP.



1 RECURRENT

If the RECURRENT-mode is selected, a new signal is recorded in register R0 and afterwards after a hold off refreshed each time that the trigger level is passed and that the selected delay has been reached.

2 MULT. ARMD

In MULTIPLE-mode (text MULT. ARMD intensified), four single shot signals can be captured sequentially. The signals are recorded in R3, R2, R1 and the last one in R0. The end of the cycle is indicated by a low intensified text ARMD.
A new cycle can be started by pushing softkey MULT. ARMD or pushbutton CLEAR and the text ARMD is intensified until the last single shot signal is recorded.

3 SING. ARMD

In SINGLE-mode (text SING. ARMD intensified) the contents of register R0 will be overwritten by a new signal when the trigger level is passed and the selected delay has been reached.
This is indicated by a low intensified text ARMD.
If afterwards a new single shot signal should be captured the same SING. ARMD softkey or pushbutton CLEAR should be pushed and the text ARMD is intensified until the single shot signal is recorded.

4 MAX RESOL.

In the time base range 200 ns/div. ... 500 us/div. the resolution of the display can be increased. Pushing MAX RESOL. activates a higher resolution. The pilot lamp REP ONLY indicates that a repetitive signal is required for this mode. If AVERAGE is selected, the instrument automatically selects MAX RESOL. When MIN / MAX is active the MAX RESOL. mode is deselected. In both situations the function is not displayed in the menu.

5 ROLL

If softkey ROLL is pushed, the ROLL-mode is selected and time-base speeds from 50 ms/div. ... 360 s/div. can be selected. The ROLL-mode is then automatically active. The text RUN is intensified during an active ROLL-mode operation, the input signal is then recorded in the register R0 and is moving over the C.R.T. screen from the right to the left.
During the ROLL-mode the contents of register R0 can be copied via the SAVE/PLOT menu in one of the registers R1, R2 or R3 if required.

6 RUN STOP

This text is only displayed if the ROLL-mode is selected. With this softkey the ROLL-mode action can immediately be stopped or started. The selected function is intensified.
In this mode no trigger selections are possible and a message

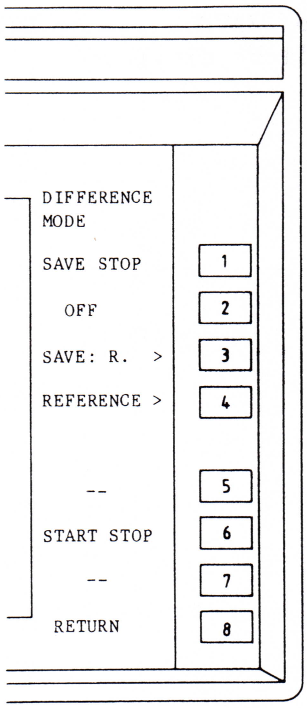
NO TRIGGER selections possible in manual ROLL mode.

is displayed if a trigger selection is done.

7 TRIG.STOP (When ROLL active)

This text is only displayed if the ROLL-MODE is selected. With this softkey the ROLL-mode action can be stopped on receipt of a trigger signal.
If this softkey is pushed the text TRIG.STOP is intensified.
If a trigger delay zero is selected, then the ROLL mode continues until the trigger stop point is at the left side of the screen. Then the action stops. This is indicated by an intensified text STOP.
By selecting another trigger delay this point can be set more to the left (positive trigger delay) or more to the right (negative trigger delay = pretrigger).
A new picture can be built up by depressing softkey RUN or pushbutton CLEAR.
For more details see section 4.3.10.3 (detailed operating information).

7 DIFFERENCE> (When in ROLL see TRIG.STOP above)



DIFFERENCE is only displayed when in RECURRENT and can only then be selected.
After selecting DIFFERENCE, the DIFFERENCE MODE menu will be displayed, difference parameters can be selected and DIFFERENCE can be started or stopped.

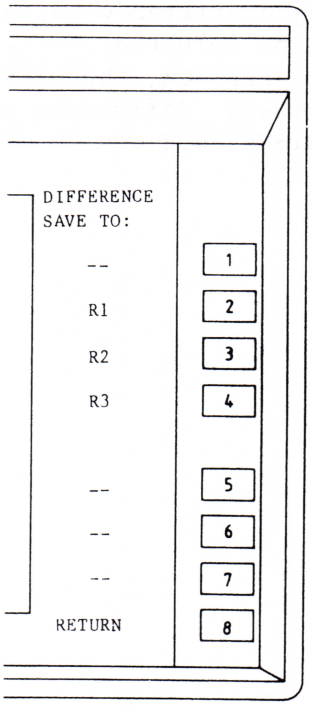
7 1 SAVE STOP

This softkey allows selection between SAVE ON DIFFERENCE and STOP ON DIFFERENCE.
In both modes, the result of an acquisition stroke in RØ is compared with a reference signal in R1, R2 or R3.
If SAVE ON DIFFERENCE is selected, then the signal in RØ is saved in R1, R2 or R3 if one or more of the dots of RØ exceeds the limits of the reference signal.
If STOP ON DIFFERENCE is selected then the acquisition stops if one or more of the dots of RØ exceeds the limits of the reference signal.

7 2 OFF

Pushing this softkey turns the SAVE ON DIFFERENCE mode or the STOP ON DIFFERENCE mode off and returns to normal recurrent mode.

7 3 SAVE:R1>



After selection of SAVE:R.., the DIFFERENCE SAVE TO: menu will be displayed.

7 3 1 --

7 3 2 R1

7 3 3 R2

7 3 4 R3

With these softkeys, the register can be selected in which the contents of RØ will be saved by the SAVE ON DIFFERENCE function.

7 3 5 --

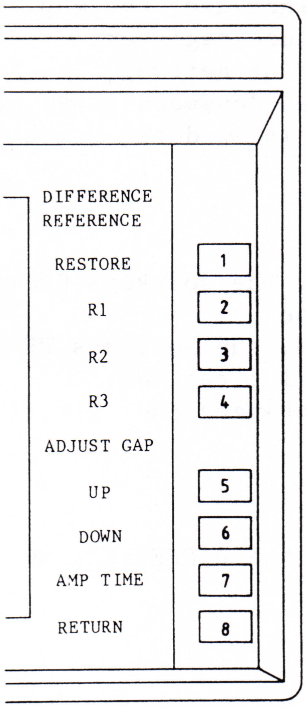
7 3 6 --

7 3 7 --

7 3 8 RETURN

After pushing softkey RETURN, the DIFFERENCE MODE menu is displayed again.

7 4 REFERENCE>



After selecting REFERENCE, the DIFFERENCE REFERENCE menu will be displayed and a reference register can be selected. Also the contents of a reference register can be determined.

7 4 1 RESTORE

This function saves the contents of RØ in the selected reference register.

7 4 2 R1

7 4 3 R2

7 4 4 R3

With these softkeys the register can be selected, which is used as the reference register for the SAVE ON DIFFERENCE and the STOP ON DIFFERENCE functions.

7 4 5 UP

Pushing softkey UP increases the gap of the signals in the selected reference register.
Depending on the AMP TIME setting, the top limit (Max. points) are moved upward (AMP) or to the right (TIME). The increment is 40 dots, which is 0.1 division on the screen.

7 4 6 DOWN

Pushing softkey down increases the gap, of the signals in the selected reference register.
Depending on the AMP TIME setting, the bottom limit (Min. points) are moved downward (AMP) or to the left (TIME). The increment is 40 dots, which is 0.1 division on the screen.

7 4 7 AMP TIME

If AMP is intensified, the softkeys UP and DOWN operate in a vertical direction.
If TIME is intensified, the softkeys UP and DOWN operate in a horizontal direction.
Pushing the softkey, changes the selection from AMP to TIME or reverse.

7 4 8 RETURN

After pushing RETURN, the DIFFERENCE MODE menu is displayed again.

7 5 --

7 6 START STOP

Pushing this softkey starts or stops the SAVE ON DIFFERENCE or the STOP ON DIFFERENCE mode, depending on which mode was selected. The actual situation is displayed intensified.

7 7 --

7 8 RETURN

After pushing RETURN, the HORIZONTAL MODE menu is displayed again.

8 --

4.2.7 TRIGGER SECTION AND MENU STRUCTURE

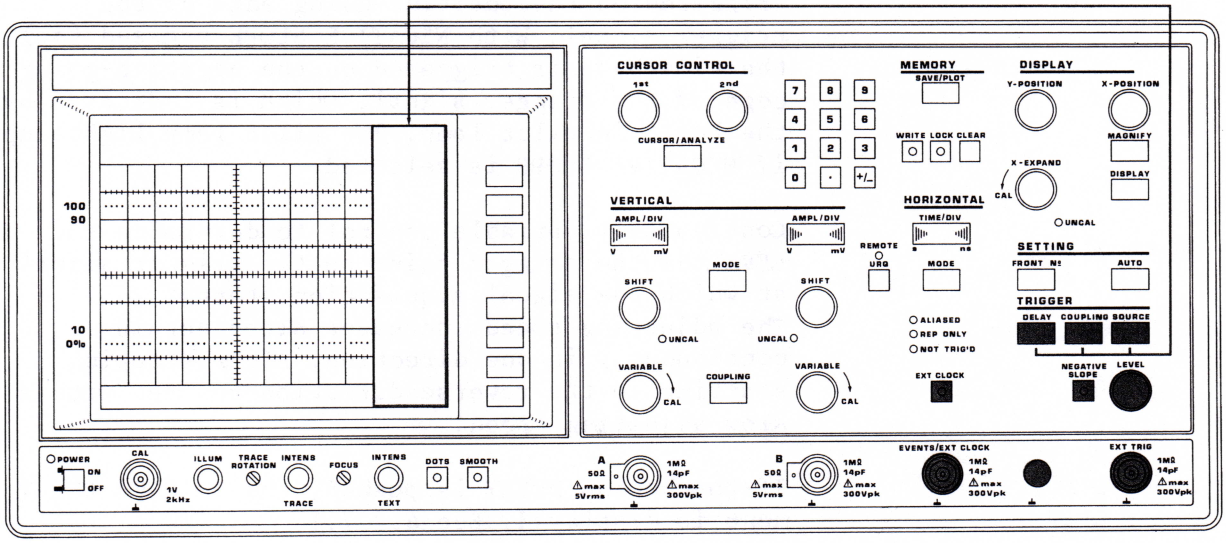
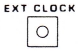


Figure 4.15 Front panel view.

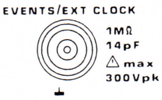


Selection of an external applied sampling clock. This means that the conversion rate depends on the signal which is applied to the EVENTS/EXT CLOCK input BNC socket and that the internal time-base circuit is switched off. The signal level on which the system reacts can be softkey selected via function EV/EXT CLK in menu TRIGGER COUPLING.

If EXT CLOCK is selected by pushing pushbutton EXT CLOCK, and EVENTS trigger delay was selected before, a message

EXTERNAL CLOCK selected with EVENTS active!
EVENTS switched off.

is displayed.

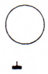


EXT CLOCK

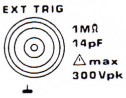
BNC input socket for external applied clock signals.
The maximum clock frequency is 50 kHz.
Pushbutton EXT CLOCK must be pressed; built in pilot lamp lights.

EVENTS

BNC input socket for external applied events for trigger delay. For this function pushbutton EXT CLOCK must be switched off.

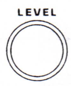


Measuring earth socket.



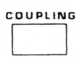
BNC input socket for external triggering, to be used in combination with the trigger source selection facility.

With NEGATIVE SLOPE off, the time base is triggered on the positive-going edge of the trigger signal. With NEGATIVE SLOPE pressed (on), the time base is triggered on the negative-going edge of the trigger signal, which is indicated by the built in pilot lamp. The pilot lamp lights up if NEGATIVE SLOPE is selected.

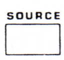


Continuously-variable control to determine the LEVEL of the trigger point on the trigger signal at which the signal acquisition starts.
The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.

If pushbutton DELAY is pushed, the TRIGGER DELAY menu is displayed. See 4.2.7.1.



If pushbutton COUPLING is pushed, the TRIGGER COUPLING menu is displayed. See 4.2.7.2.



If pushbutton SOURCE is pushed, the TRIGGER SOURCE menu is displayed. See 4.2.7.3.

4.2.7.1 TRIGGER DELAY MENU STRUCTURE

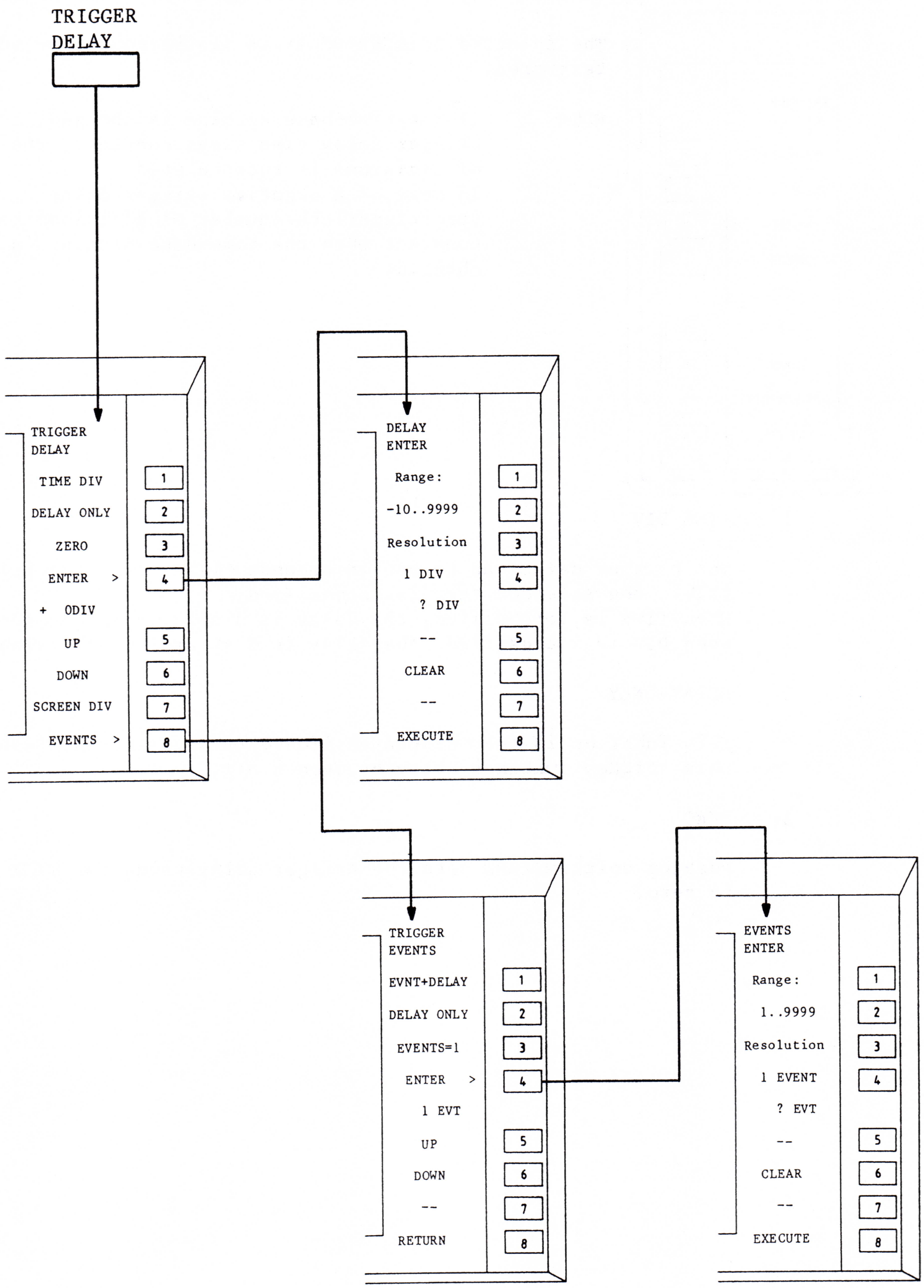
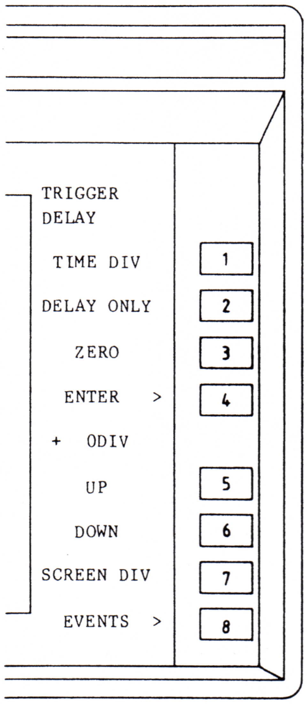


Figure 4.16 Trigger delay menu structure.

TRIGGER DELAY MENU



After pushing the DELAY pushbutton, the TRIGGER DELAY menu is displayed and the trigger delay can be selected

The selected TRIGGER DELAY is displayed in the softkey text area.

NOTE If the time-base setting is changed, the trigger delay time stays constant, the number of divisions is recalculated.
In case of a negative trigger delay (pretrigger) the number of divisions remains constant when the time-base setting is changed.

1 TIME DIV

The trigger delay can be set in seconds (TIME) or in divisions (DIV), the selected text is intensified.
When TIME is intensified, the delay is displayed in seconds,and when DIV is intensified, the delay is displayed in divisions.

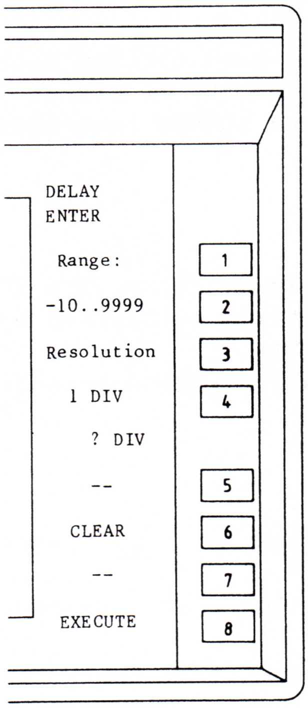
2 DELAY ONLY

This function is only displayed if events is selected. Pushing this softkey switches delay by events off.

3 ZERO

Pushing softkey ZERO sets the trigger delay value for TIME or DIV to zero.

4 ENTER>



After selecting ENTER, the DELAY ENTER menu will be displayed and the trigger delay can be selected with the numeric keyboard.
The actual range is indicated and the value is visible in the softkey text area.

Possible texts for:

TIME : .. s (ms and us)
DIVISIONS : .. DIV

A message

Too many digits: total entry is cleared.

will be displayed if too many digits are entered via the numeric keyboard.

A message

No decimal point allowed in this enter menu.

will be displayed if a decimal point is entered via the numeric keyboard.

4 1 --

4 2 --

4 3 --

4 4 --

4 5 --

4 6 CLEAR

If an error is made, the trigger delay value can be cleared by pushing softkey CLEAR.

4 7 --

4 8 EXECUTE

After pushing this softkey, the selected trigger delay value is entered and an AUTO RETURN is performed to the TRIGGER DELAY menu.
If after CLEAR the softkey EXECUTE is pressed the trigger delay value keeps its previous value in the TRIGGER DELAY menu.

A message

TRIGGER DELAY number out of range.

will be displayed if the entered value exceeds the given range.

5 UP

Pushing softkey UP increments the trigger delay.
The TIME increases in steps of the time-base setting multiplied by 1 or by 10 depending on the setting SCREEN or DIV.
DIV increases in steps of 1 division and SCREEN increases in steps of 1 screen.

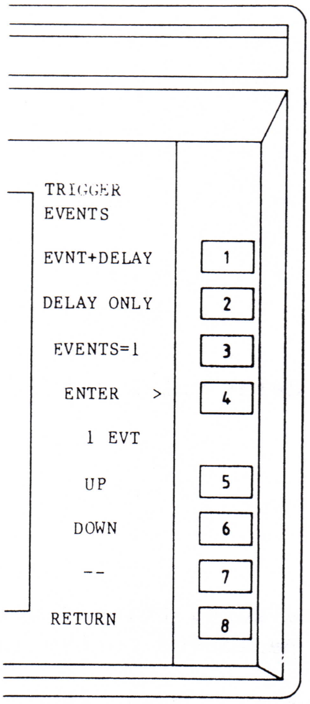
6 DOWN

Pushing softkey DOWN decrements the trigger delay. The TIME decreases in steps of the time-base setting multiplied by 1 or by 10 depending on the setting SCREEN or DIV.
DIV decreases in steps of 1 division and SCREEN decreases in steps of 1 screen.

7 SCREEN DIV

If the text SCREEN is intensified, the UP and DOWN softkeys operate with 1 screen.
If the text DIV is intensified, the UP and DOWN softkeys operate with 1 division.
Pushing this softkey changes the selection from SCREEN to DIV or reverse.

8 EVENTS>



After selecting EVENTS the TRIGGER EVENTS menu will be displayed and a trigger delay by events can be selected.
The selected number of events is displayed in the softkey text area.

8 1 EVNT + DELAY

Pushing this softkey activates the EVENTS + DELAY triggering. The softkey text is intensified then.
After a trigger, the selected number of events is counted down, after which the acquisition starts (see section 4.3.9).
If the DELAY is not zero, then the acquisition starts after the count down of EVENTS and the DELAY. Delay by EVENTS can also be combined with a negative DELAY in TIME or DIV (pretrigger).

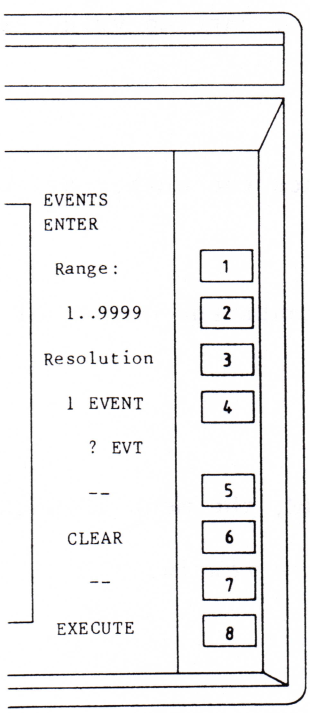
8 2 DELAY ONLY

Pushing this softkey, switches the delay by EVENTS OFF; the delay in TIME or DIV remains.
This text is only displayed if delay by EVENTS is active.

8 3 EVENTS = 1

Pushing the softkey sets the selected number of EVENTS to 1.

8 4 ENTER>



After selecting ENTER, the EVENTS ENTER menu will be displayed and a numbr of events can be selected with the numeric keyboard.
The actual range is indicated and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

will be displayed if too many digits are entered via the numeric keyboard.

A message

No decimal point allowed in this enter menu.

will be displayed if a decimal point is entered via the numeric keyboard.

8 4 1 --

8 4 2 --

8 4 3 --

8 4 4 --

8 4 5 --

8 4 6 CLEAR

If an error is made, the number of events can be cleared by pushing softkey CLEAR.

8 4 7 --

8 4 8 EXECUTE

After pushing this softkey, the selected number of events is entered and an AUTO RETURN is performed to menu TRIGGER DELAY.
If after CLEAR the softkey EXECUTE is pressed the number of events keeps its previous value in the TRIGGER DELAY menu.

A message

EVENT number out of range.

will be displayed if the entered value exceeds the given range.

8 5 UP

Pushing softkey UP increments the number of events.

8 6 DOWN

Pushing softkey DOWN decrements the number of events.

8 7 --

8 8 RETURN

After pushing softkey RETURN, the menu TRIGGER DELAY is displayed again.
The selections as made before remain.

4.2.7.2 TRIGGER COUPLING MENU STRUCTURE

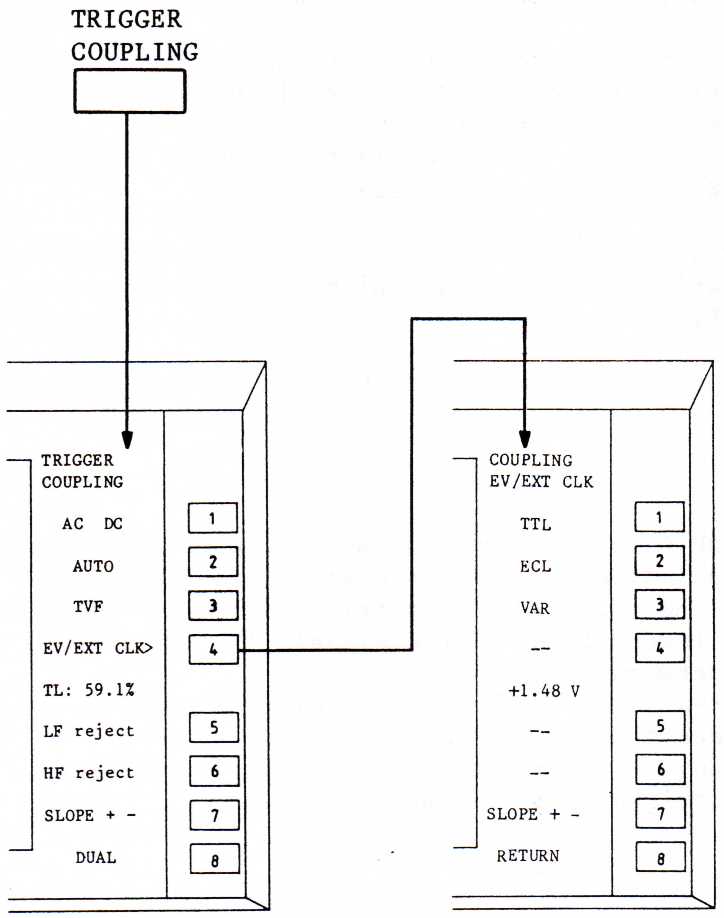
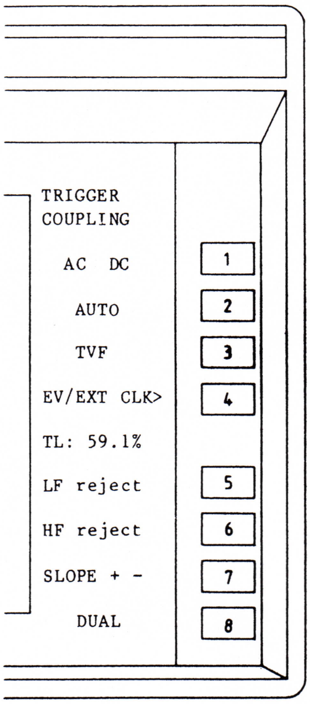


Figure 4.17 Trigger coupling menu structure.

TRIGGER COUPLING MENU



After pushing the COUPLING pushbutton, the TRIGGER COUPLING menu is displayed and different trigger modes and slopes can be selected.

The following combinations can be selected:
AC
AC HF reject
AC LF reject
DC
DC HF reject
AUTO
AUTO HF reject
AUTO LF reject
TVF (No DUAL possible)

A trigger level indication can be displayed in the softkey text area.

1 AC DC

If the text AC is intensified, AC trigger coupling is selected. Pushing the softkey again will then give DC trigger coupling and visa versa.
On the left side of the screen a trigger level indication is given with a mark I (internal), X (external) or L (line), depending on the selected trigger source.
The trigger level is also displayed in the softkey text area, except when LINE triggering is selected.

NOTE: If AC trigger coupling is selected, the trigger level indications do not reckon with a DC offset on the input signal.

If neither AC nor DC is intensified AUTO- or TVF-triggering is active.

2 AUTO

If the softkey AUTO has been pushed, automatic triggering is active, which is indicated by an intensified text AUTO.
This means that the trigger level setting is limited between the highest and the lowest level of the signal. The level setting is still possible between these limits.
In the softkey text area the trigger level is displayed as a percentage between these limits.
If LINE triggering is active, there is no trigger level indication. The trigger input is AC coupled.

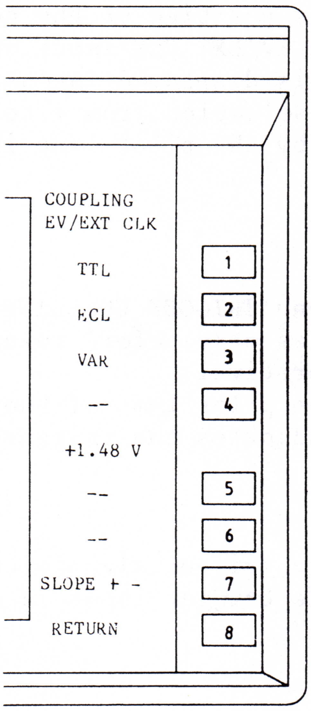
3 TVF

If TVF has been selected, television frame signal synchronisation is obtained (for CCIR system 625/525 lines).
Check the correct setting of the trigger slope (in accordance to the T.V. system under test).
If the LEVEL control is operated, a message

Leveling not possible when in TV- mode.

is displayed.

4 EV/EXT CLK>



After selecting EV/EXT CLK the COUPLING EV/EXT CLK menu is displayed and the detection levels and slope for events can be selected.

4 1 TTL

After pushing softkey TTL, the text TTL is intensified and the detection level of the EVENTS/EXT CLOCK input is set for TTL signals. The detection level is indicated by a mark E on the left side of the C.R.T. screen.

4 2 ECL

After pushing softkey ECL, the text ECL is intensified and the detection level of the EVENTS/EXT CLOCK input is set for ECL signals. The detection level is indicated by a mark E on the left side of the C.R.T. screen.

4 3 VAR

After pushing softkey VAR, the text VAR is intensified and the detection level of the EVENTS/EXT CLOCK input can manually be set by the TRIGGER LEVEL control. The detection level is indicated by a mark E on the left side of the C.R.T. screen and the actual value is displayed in the softkey text area.

4 4 --

4 5 --

4 6 --

4 7 SLOPE + -

Detection of events on either the positive or the negative slope of the input signal on the EV/EXT CLK input can be selected. The selected function is displayed intensified. Pushing the softkey changes the selection from + to - or reverse. This is also indicated by the pilot lamp in the pushbutton NEGATIVE SLOPE.

4 8 RETURN

After pushing softkey RETURN, menu TRIGGER COUPLING is displayed again. The selections as made before remain and the trigger level control is operative.
In the TRIGGER COUPLING menu, the pilot lamp of the pushbutton NEGATIVE SLOPE now indicates the trigger slope.

5 LF REJECT

With LF REJECT selected, low frequency trigger signals (up to 50 kHz) are blocked. Only possible if the trigger input is AC coupled.

6 HF REJECT

With HF REJECT selected, high frequency trigger signals (> 50 kHz) are blocked.

7 SLOPE + -

With this softkey, triggering on the positive or on the negative slope of the signal can be selected. SLOPE + - overrules DUAL selection.

8 DUAL

After selection of DUAL triggering, the instrument is able to trigger on either the positive or the negative slope of the signal. The level (positive and negative) can be adjusted by the level potentiometer.
This DUAL function is specially usefull in the SINGLE-shot mode. DUAL can not be selected in the time base range 100 ns/div ... 5 ns/div and the text DUAL is not displayed then. If DUAL is selected and this time base range is entered, a message

DUAL slope not possible in SAMPLING.
DUAL switched off.

is displayed.

4.2.7.3 TRIGGER SOURCE MENU STRUCTURE

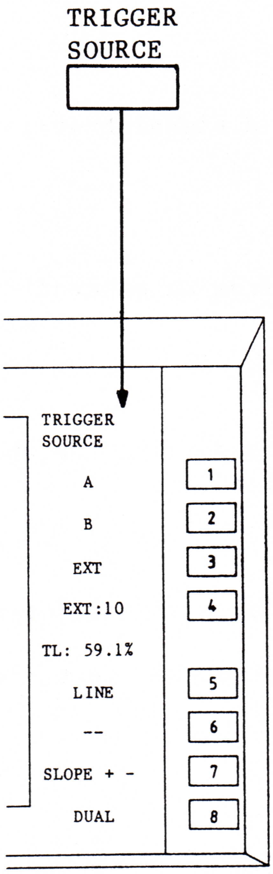
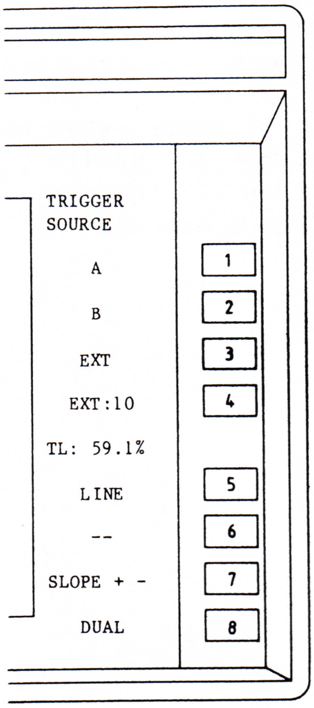


Figure 4.18 Trigger source menu structure.

TRIGGER SOURCE MENU



After pushing the SOURCE pushbutton, the TRIGGER SOURCE menu is displayed and different trigger sources, slopes and modes can be selected.

A trigger level indication can be displayed in the softkey text area.

1 A

With A selected, triggering is achieved on a signal that is internally derived from channel A.

2 B

With B selected, triggering is achieved on a signal that is internally derived from channel B.

3 EXT

With EXT selected, triggering is obtained from an external signal via the EXT TRIG input socket.

4 EXT:10

With EXT:10 selected, external triggering is obtained as above, but the signal is attenuated by a factor of 10.

5 LINE

With LINE selected, triggering is obtained by a signal internally derived from the line voltage.
There is no trigger level indication in the softkey text area.

6 --

7 SLOPE + -

With this softkey, triggering on the positive or on the negative slope of the signal can be selected. SLOPE + - overrules DUAL selection.

8 DUAL

After selection of DUAL triggering, the instrument is able to trigger on either the positive or the negative slope of the signal. The level (positive and negative) can be adjusted by the level potentiometer.
This DUAL function is specially usefull in the SINGLE-shot mode. DUAL can not be selected in the time base range 100 ns/div ... 5 ns/div and the text DUAL is not displayed then. If DUAL is selected and this time base range is entered, a message

DUAL slope not possible in SAMPLING.
DUAL switched off.

is displayed.

4.2.8 CURSOR SECTION AND MENU STRUCTURE

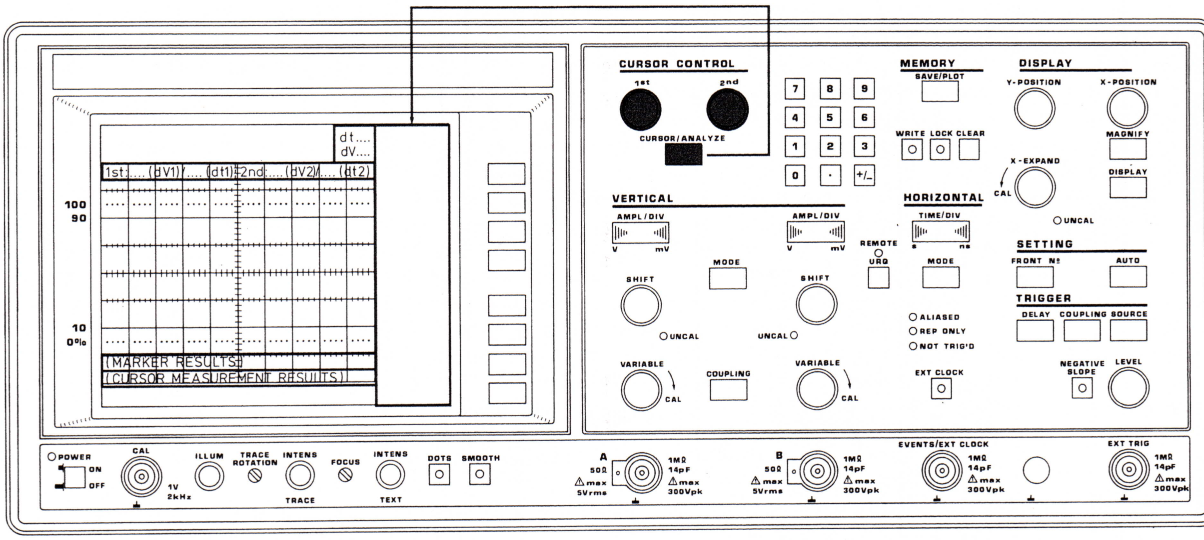
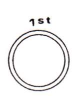
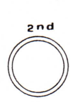


Figure 4.19 Front panel view.



This control functions when cursor operation is switched on via the CURSORS SELECT menu.
Continuously variable control to determine the position of the 1st cursor (most left cursor) on the screen.
Range lies between the most left and most right side of the trace visible on the C.R.T. screen.
The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.
The trace on which the cursor is positioned, can beselected via the CURSOR SELECT menu.



This control functions when cursor operation is switched on via the CURSORS SELECT menu.
Continuously variable control to determine the position of the 2nd cursor (most right cursor) on the screen.
Range lies between the most left and most right side of the trace visible on the C.R.T. screen.
The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.
The trace on which the cursor is positioned can, be selected via the CURSOR SELECT menu.

CURSOR/ANALYZE

If pushbutton CURSOR/ANALIZE is pushed, the CURSORS SELECT menu is displayed. See 4.2.8.1.

Calculation results are displayed in the top of the C.R.T. screen.

dt .... — dt .... time between the cursors.

dV .... — dV .... voltage difference between the cursors.

1st .(dV1)/.(dt1) — 1st ../.. results of left cursor measurements.
.(dt1) time between first cursor and trigger.
.(dV1) voltage between first cursor and zero.

2nd .(dV2)/.(dt2) — 2nd ../.. results of right cursor measurements.
.(dt2) time between second cursor and trigger.
.(dV2) voltage between second cursor and zero.

4.2.8.1 Cursor/Analyze menu structure.

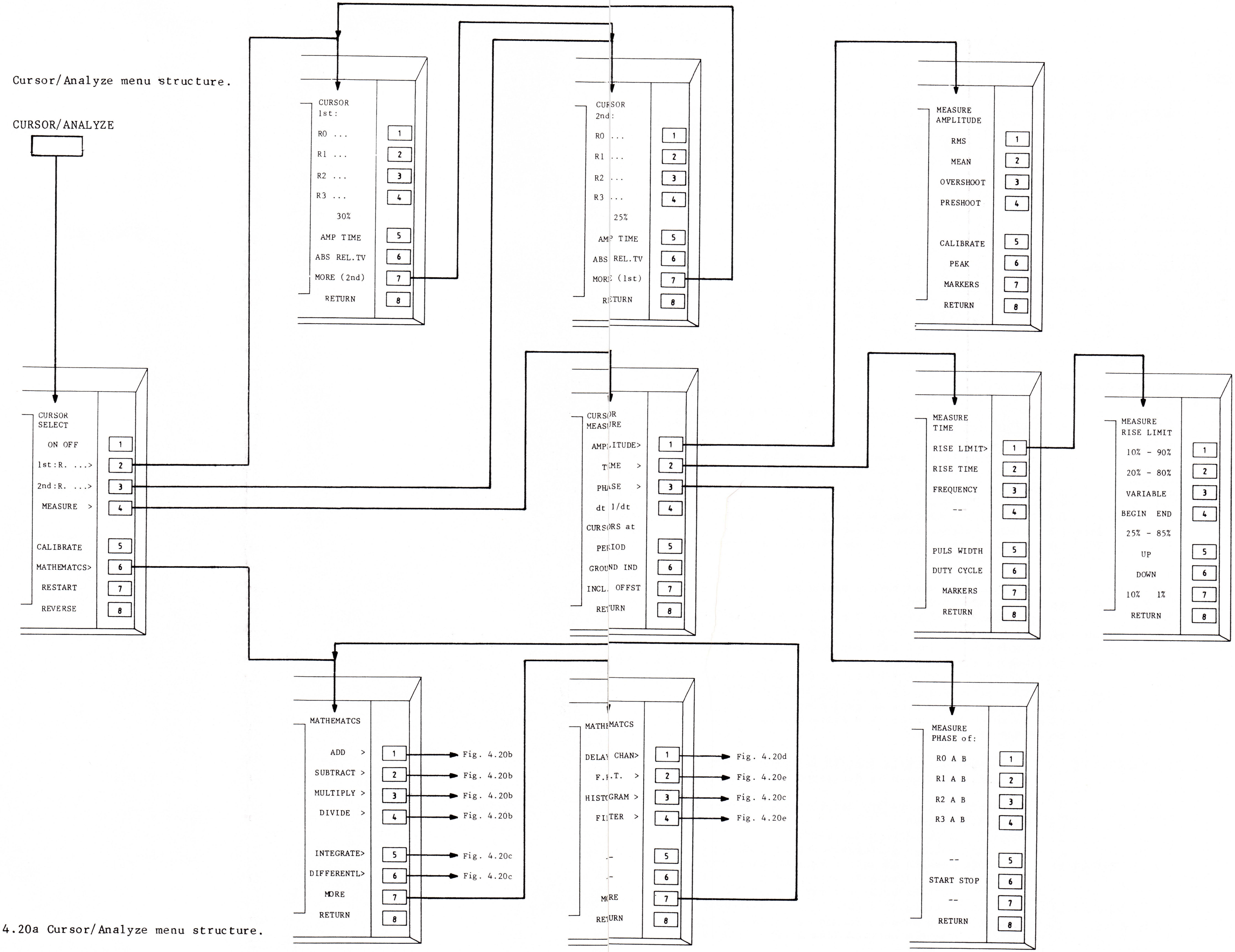


Figure 4.20a Cursor/Analyze menu structure.

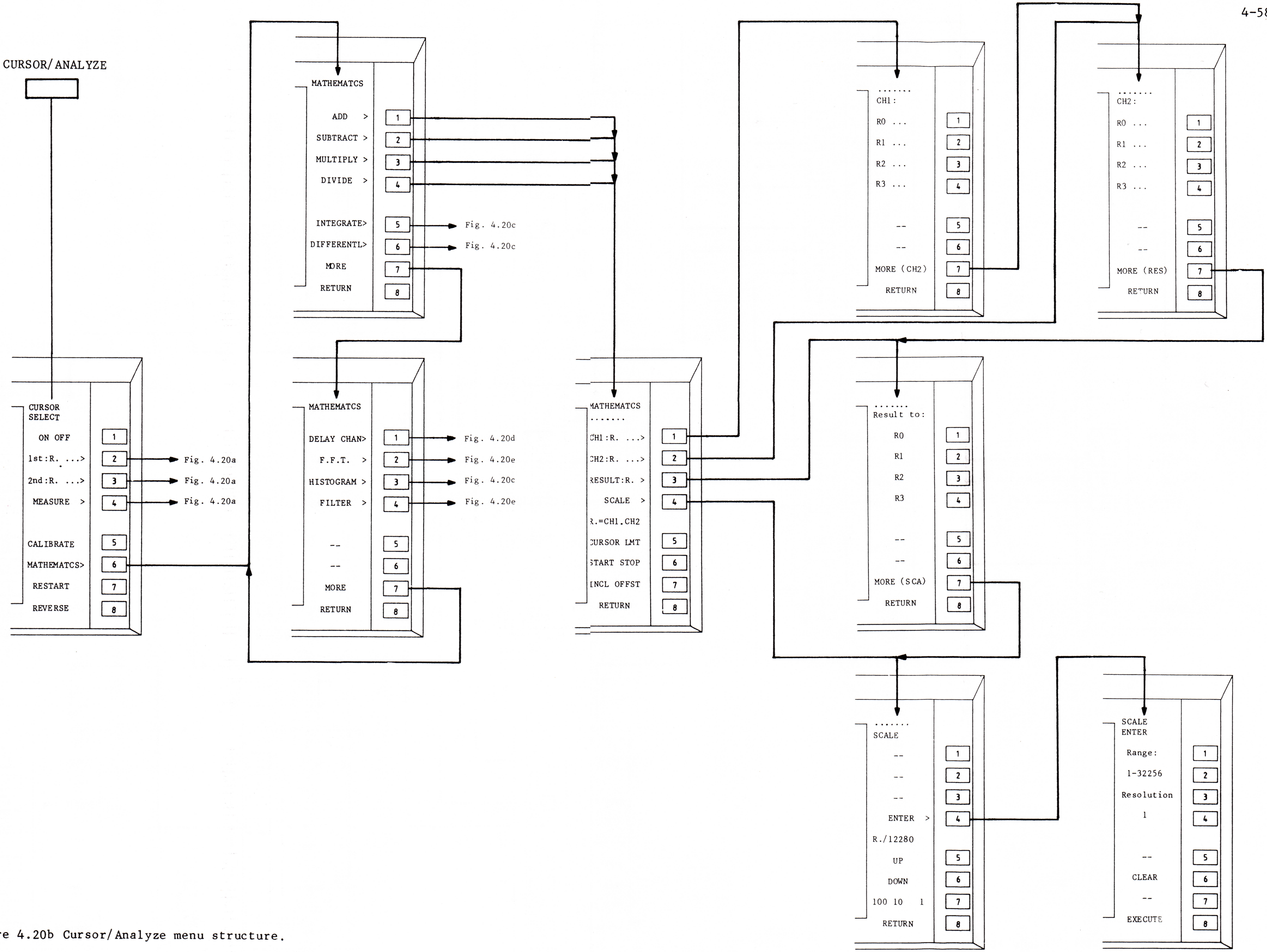


Figure 4.20b Cursor/Analyze menu structure.

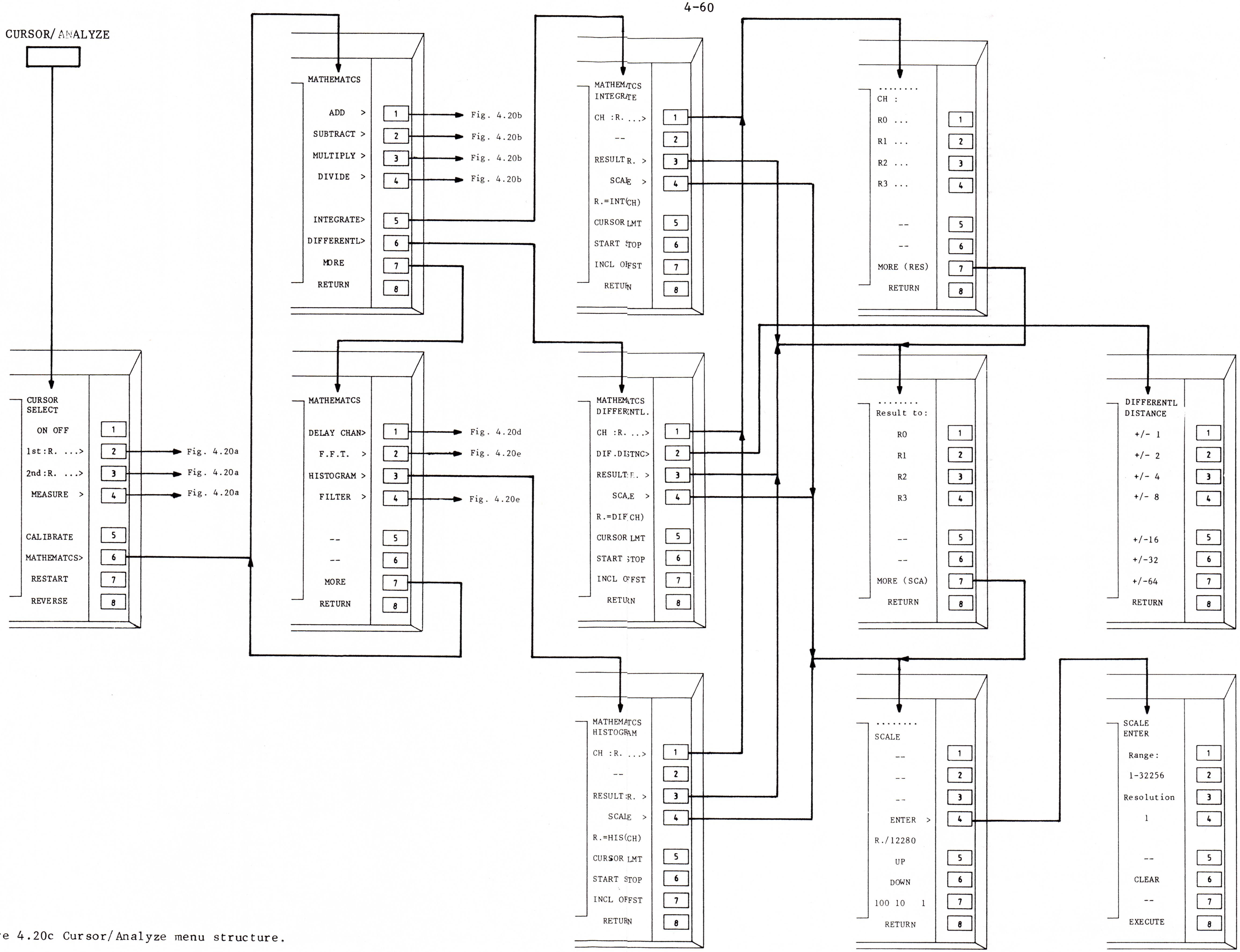


Figure 4.20c Cursor/Analyze menu structure.

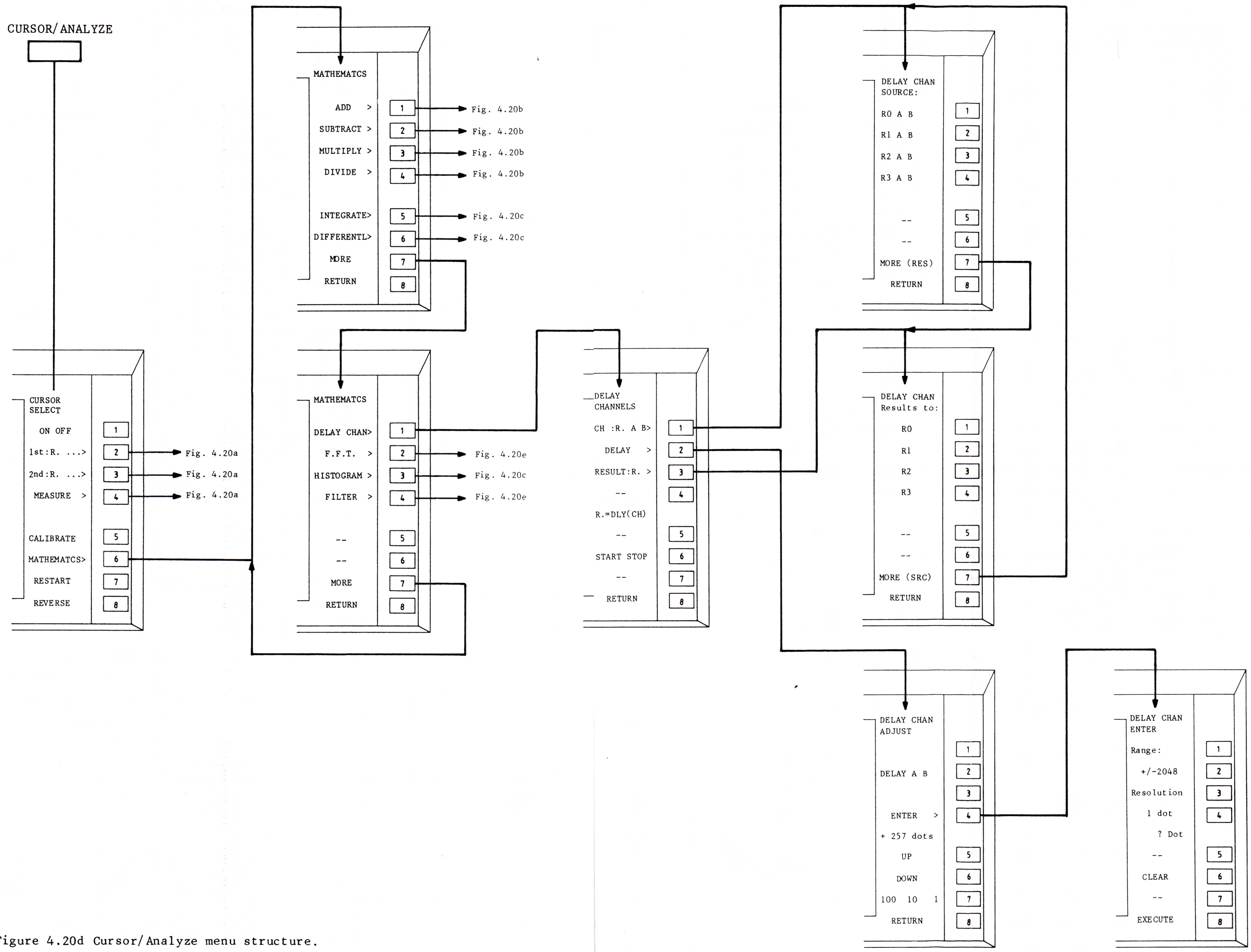


Figure 4.20d Cursor/Analyze menu structure.

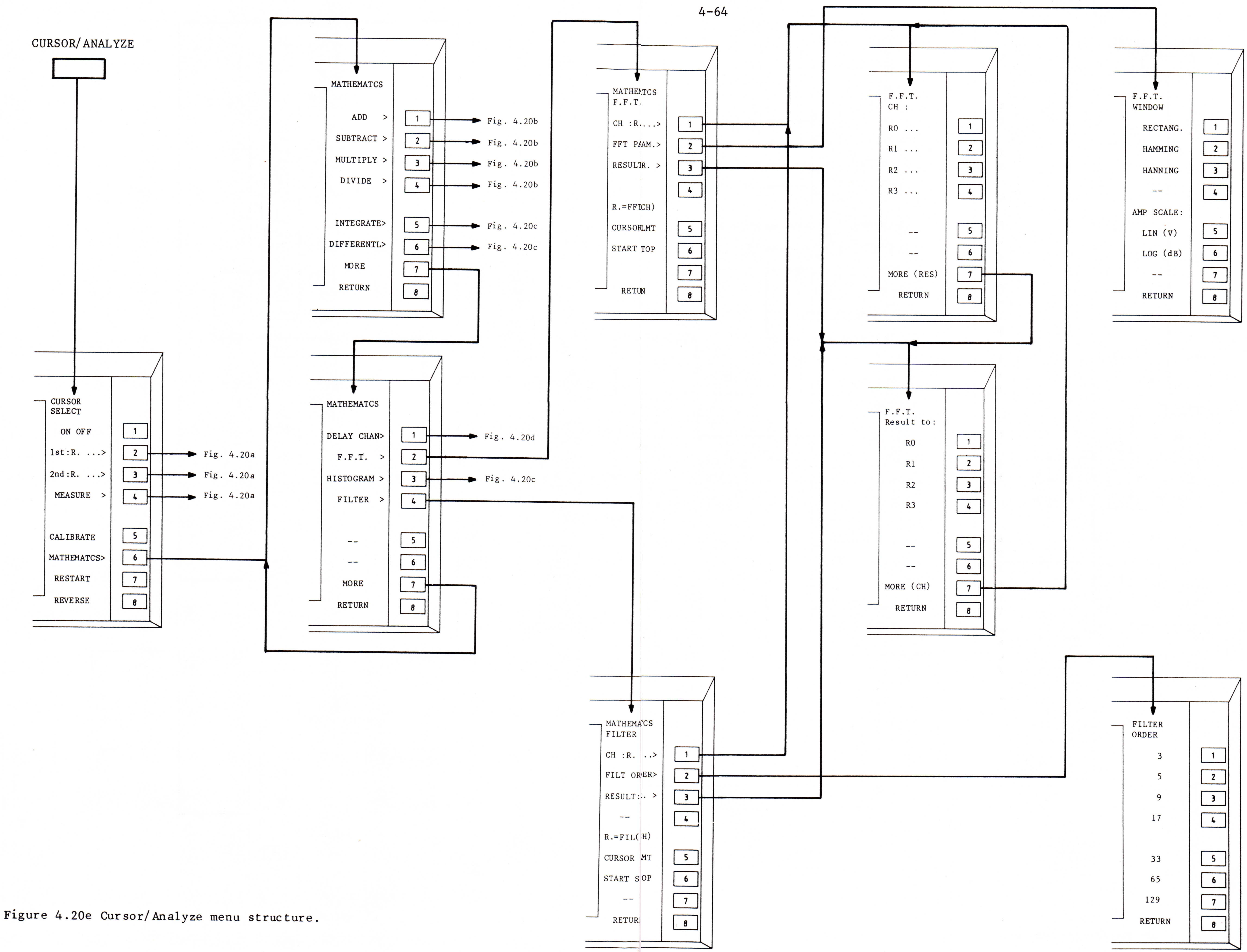
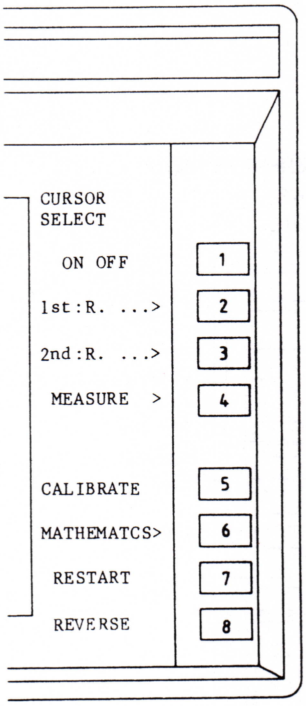


Figure 4.20e Cursor/Analyze menu structure.

CURSOR MENU



After pushing pushbutton CURSOR, the CURSOR SELECT menu is displayed and the cursors 1st and 2nd can be set at choice for various measurements using the controls 1st and 2nd.
The cursors are displayed on the previous selected positions.
As soon as the cursors (crossed lines with a length of 2 divisions) are visible, the horizontal distance between the cursors and between cursor and trigger is measured and displayed . The vertical distance between the cursors and between cursor and ground is measured and displayed. The cursors can be positioned on different registers or channels.
The vertical and horizontal distance between the cursors are dispayed in the top text area.

When positioning cursor 1st and cursor 2nd, they can not pass each other. Cursor 1st is always the left one and cursor 2nd is always the right one.

Cursors range lies between the left and the right side of the visible traces on the screen.

The displayed calculation results are continuously recalculated.

IMPORTANT NOTE:

In LOCK the TIME/DIV and AMPL/DIV settings can be changed, which is displayed in the top text area of the screen.
The displayed cursor values are valid for the picture on the screen, so they don't correspond with the TIME/DIV and AMPL/DIV settings in the top text area.
The correct settings can be found in the bottom text area, if FULL TEXT display is selected via the DISPLAY menu.

At power-down, the last selected cursor positions are saved in memory.

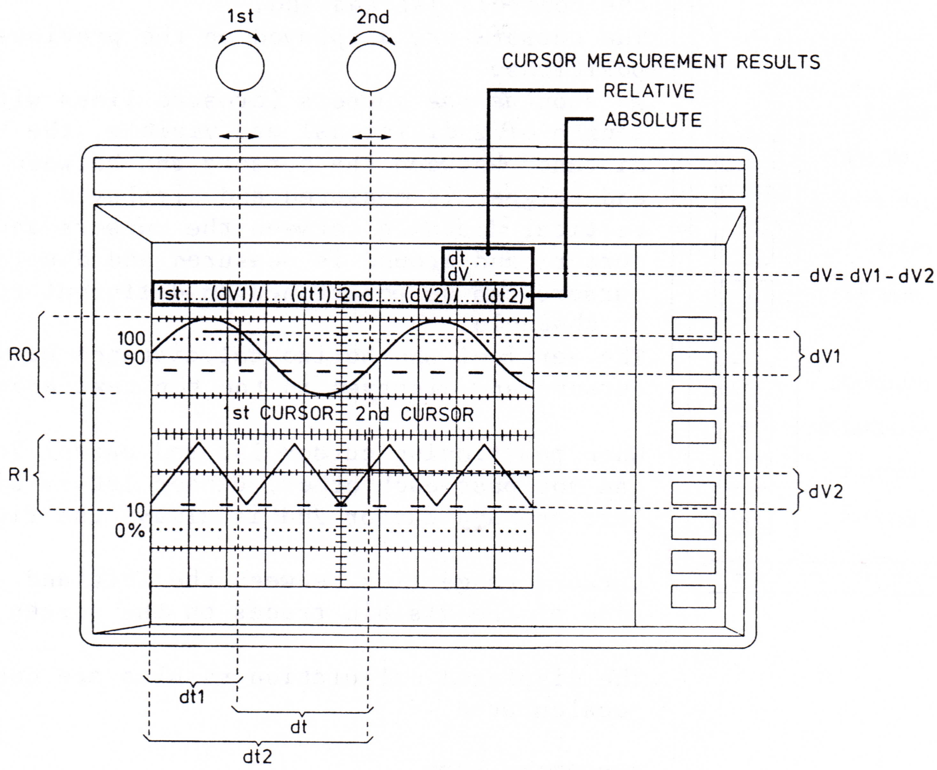
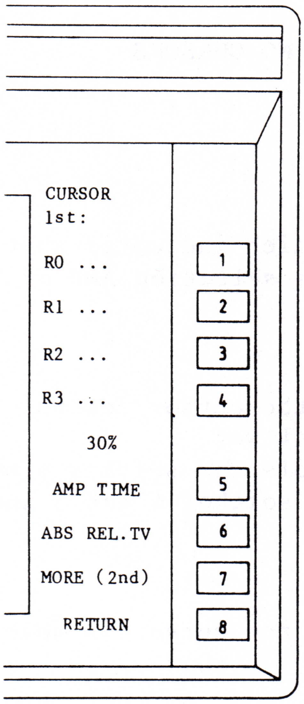


Figure 4.21 Cursor display and control.

1 ON OFF

Softkey 1 has a toggle function and switches ON and OFF the cursors. The actual function is displayed.
When the cursors are switched ON, they will appear on the last selected position.
If one of the registers or channels, in which a cursor was positioned, is switched off (invisible), this cursor will be positioned in the same register and trace as the other cursor.
If both cursors were positioned in a now invisible register or channels, they will be positioned in the first visible trace that is found. Searching starts at Register R0 and channel A.
The cursor result text line, in the top of the graticule, will display the voltage and the time (from the trigger).

2 1st:R. ...>



This function is only displayed when cursors are switched ON.
It initiates a menu in which the (cursor) register is selected and the way the cursor is moved.
The cursor can be placed on any channel or register, provided it is displayed.
If a register containes two channels, the corresponding softkey will function as a toggle key between the channels after the register is selected.
The text area of this softkey indicates the register (and channel) in which this cursor is positioned.
The AMP TIME and ABS RELTV selection made here is also valid for the 2nd cursor.

2 1 R0 ...

2 2 R1 ...

2 3 R2 ...

2 4 R3 ...

If a register is selected for cursor operation the cursor is visible on the screen for the selected (intensified) channel. The other channel can be selected by pushing the softkey once again.
Only displayed registers will appear in the menu.
The previous position of a cursor in a register is displayed when it is selected again.

Possible displays for the cursor positions are:
(R. A B), (R. A), (R. B), (R. ADD), (R. SUB), (R. MUL), (R. DIV), (R. INT), (R. DIF), (R. DEL), (R. FFT), (R. HYS) or (R. FIL).

If register R0 and one channel is selected for both cursors, the Text RESTART is visible next to softkey 7 and an automatic selection of time base setting and/or delay is possible (see explanation for softkey 7).

If A versus B was selected for the selected register a message

REGISTER IN A VERSUS B: NO CURSORS POSSIBLE

is displayed and the cursors are switched off.

If a register is selected in which no traces and settings are stored, a message

REGISTER HAS NO LEGAL SETTINGS: NO CURSORS

is displayed.

2 5 AMP TIME

AMP TIME is a toggle function which indicates what way the cursor control knob is used. The selection AMP or TIME is valid for both cursors.

AMP function
The AMP function active means, the cursor control will position the cursor in a vertical way.
The text ABS RELTV becomes visible for softkey 6 when AMP is selected. The text line between softkey 4 and 5 indicates the position of the cursor.

TIME function
The TIME function active means, the cursor is moved horizontal.

2 6 ABS RELTV

Displayed when AMP is selected by softkey 5.
The selection is valid for both cursors.

ABS function
Indicates that the positioning of the cursor is in Volts. If the voltage of the cursor is not found on the signal, an error message is displayed and the cursor is positioned on the nearest value. The voltage is indicated between softkeys 4 and 5.

RELTV function
This function will put the cursor on a relative vertical position on the signal. The 0% and 100% are the peak-peak values of the signal between the cursors. The percentage is indicated between softkeys 4 and 5.

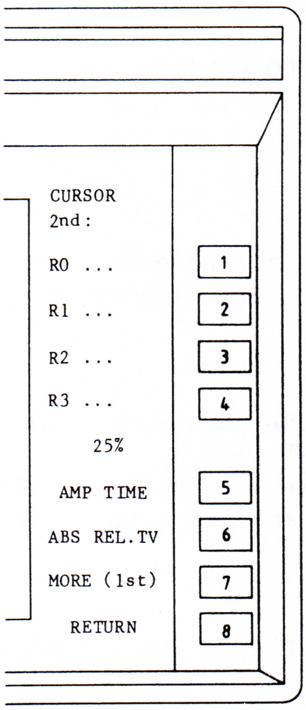
2 7 MORE (2nd)

If MORE (2nd) is selected, the selection menu for the second cursor will appear. MORE (2nd) has the same result as pressing RETURN and then 2nd:R. ...

2 8 RETURN

After pushing softkey RETURN, the cursor SELECT menu becomes visible.

3 2nd:R. ...>



This function is only displayed when cursors are switched ON.
It initiates a menu in which the (cursor) register is selected and the way the cursor is moved.
The cursor can be placed on any channel or register, provided it is displayed.
If a register containes two channels, the corresponding softkey will function as a toggle key between the channels after the register is selected.
The text area of this softkey indicates the register (and channel) in which this cursor is positioned.
The AMP TIME and ABS RELTV selection made here is also vallid for the 1st cursor.

3 1 R0 ...

3 2 R1 ...

3 3 R2 ...

3 4 R3 ...

If a register is selected for cursor operation the cursor is visible on the screen for the selected (intensified) channel. The other channel can be selected by pushing the softkey once again.
Only displayed registers will appear in the menu.
The previous position of a cursor in a register is displayed when it is selected again.

Possible displays for the cursor positions are:
(R. A B), (R. A), (R. B), (R. ADD), (R. SUB),
(R. MUT), (R. DIV), (R. INT), (R. DIF), (R. DEL),
(R. FFT), (R. HYS) or (R. FIL).

If register R0 and one channel is selected for both cursors, the Text RESTART is visible next to softkey 7 and an automatic selection of time base setting and/or delay is possible (see explanation for softkey 7).

If A versus B was selected for the selected register a message

REGISTER IN A VERSUS B: NO CURSORS POSSIBLE

is displayed and the cursors are switched off.

If a register is selected in which no traces and settings are stored, a message

REGISTER HAS NO LEGAL SETTINGS: NO CURSORS

is displayed.

3 5 AMP TIME

AMP TIME is a toggle function which indicates what way the cursor control knob is used. The selection AMP or TIME is valid for both cursors.

AMP function
The AMP function active means, the cursor control will position the cursor in a vertical way.
The text ABS RELTV become visible for softkey 6 when AMP is selected. The text line between softkey 4 and 5 indicates the position of the cursor.

TIME function
The TIME function active means, the cursor is moved horizontal.

3 6 ABS RELTV

Displayed when AMP is selected by softkey 5.
The selection is valid for both cursors.

ABS function
Indicates the positioning of the cursor is in Volts.
If the voltage of the cursor is not found on the signal, an error message is displayed and the cursor is positioned on the nearest value. The voltage is indicated between softkeys 4 and 5.

RELTV function
This function will put the cursor on a relative vertical position on the signal. The 0% and 100% are the peak-peak values of the signal between the cursors. The percentage is indicated between softkeys 4 and 5.

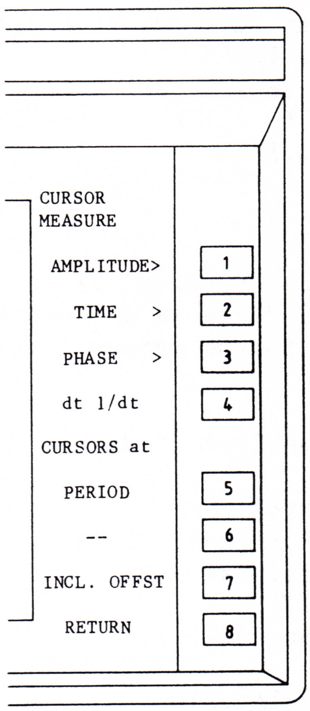
3 7 MORE (1st)

If MORE (1st) is selected the selection menu for the second cursor will appear. MORE (1st) will have the same result as pressing RETURN and then 1st:R. ...

3 8 RETURN

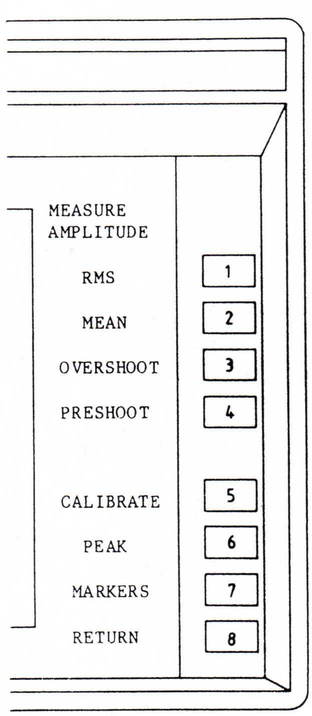
After pushing softkey RETURN, the cursor SELECT menu becomes visible.

4 MEASURE>



If MEASURE is selected, the CURSOR MEASURE menu is displayed and a choise of cursor related measurements can be selected.
The text MEASURE is only visible when the cursors are switched ON.
To get the choise of amplitude and time measurements, the cursor must be related to the same trace.
A maximum of three measurements can be selected and displayed in the measurement result text area (see also section 4.2.2).

4 1 AMPLITUDE>



By pushing AMPLITUDE, the MEASURE AMPLITUDE menu is displayed.
This function AMPLITUDE is only visible when both cursors are related to one channel.
The CALIBRATE function is also in this menu implemented because of the importance of a correct ground-level in the RMS and MEAN calculations.
MARKERS will only be visible when OVERSHOOT, PRESHOOT or PEAK is selected and act on the active measurement with the highest position in the menu.
Results are displayed at the bottom of the graticule.

4 1 1 RMS

After pushing RMS (Root Mean Square), the RMS value of the signal detail between the cursors is calculated.
This RMS is related to the ground level.
Therefor it is recommended to calibrate the channel before reading the RMS result.

4 1 2 MEAN

After pushing MEAN, the mean value of the signal detail between the cursors is calculated.
This MEAN value is related to the ground level. Therefor it is recommended to calibrate the channel before reading the MEAN result.

4 1 3 OVERSHOOT

After pushing OVERSHOOT, the OVERSHOOT value of the signal detail between the cursors is calculated. This OVERSHOOT value is related to the cursor levels according the formula:

When level 1st is lower than level 2nd:

$$\text{OVERSHOOT} = \frac{\text{level peak} - \text{level 2nd}}{\text{level 2nd} - \text{level 1st}} * 100\%$$

When level 2nd is lower than level 1st:

$$\text{OVERSHOOT} = \frac{\text{level 2nd} - \text{level minimum}}{\text{level 1st} - \text{level 2nd}} * 100\%$$

4 1 4 PRESHOOT

After pushing PRESHOOT, the PRESHOOT value of the signal detail between the cursors is calculated.
This PRESHOOT value is related to the cursor levels according the formula:

When level 1st is lower than level 2nd:

$$\text{PRESHOOT} = \frac{\text{level 1st} - \text{level minimum}}{\text{level 2nd} - \text{level 1st}} * 100\%$$

When level 2nd is lower than level 1st:

$$\text{PRESHOOT} = \frac{\text{level peak} - \text{level 1st}}{\text{level 1st} - \text{level 2nd}} * 100\%$$

4 1 5 CALIBRATE

After pushing CALIBRATE, the analog input circuits are calibrated. The CALIBRATE procedure will calculate the ground level correction, the shift correction and the offset correction, which are used to get correct measurement values.
Same as CALIBRATE in the main (CURSOR SELECT) menu.

4 1 6 PEAK-PEAK

After pushing sofktey PEAK-PEAK, the voltage between the lowest and the highest point of the signal between two cursors, will be calculated and displayed in the measurement result text are.
When PEAK-PEAK is selected, the text MARKERS becomes visible for softkey 7.

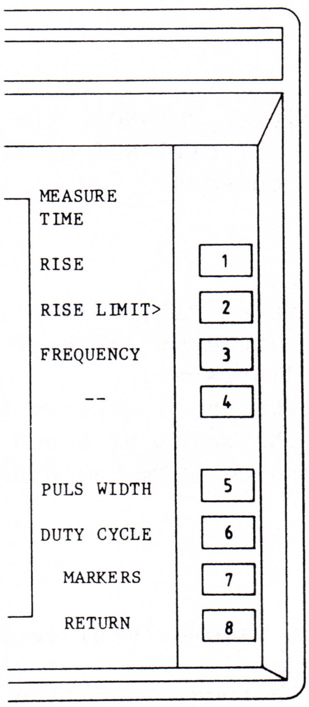
4 1 7 MARKERS

After pushing softkey MARKERS, the MARKERS become visible on the signal that is selected for both cursors.
The MARKERS, two vertical lines, are placed on that positions that are used for the selected measurement. Just above the measurement results, the absolute values, of the signal at the marker positions, are displayed in relation to the ground level and the trigger (see section 4.2.2).

4 1 8 RETURN

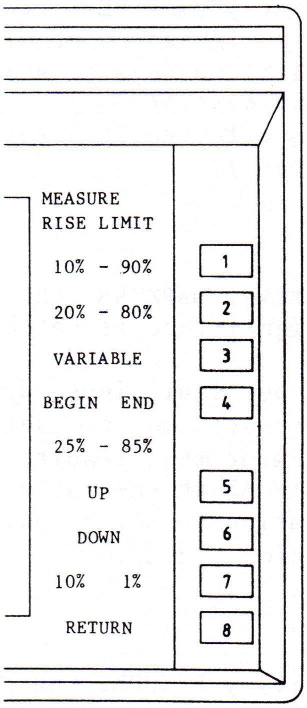
After pushing softkey RETURN, the CURSOR MEASURE menu will be visible again.
The results of the selected measurements are still displayed.

4 2 TIME>



If TIME is selected, the MEASURE TIME menu is displayed and a number of TIME measurements can be selected.
The time measurement results are displayed in the measurement result text area in the the bottom of the graticule.
The text MARKERS becomes visible when a time measurement is selected. The markers are valid for the active measurement with the highest position in the menu.

4 2 1 RISE LIMIT>



If RISE LIMIT is selected, the MEASURE RISE LIMIT menu is displayed and the limits used for RISE TIME calculation are selected.
Fixed limits are selected by the softkeys 1 and 2, or variable limits by softkey 3 and 4.
When VARIABLE is selected, softkey text is displayed at softkeys 4, 5, 6 and 7, to change the limits of the RISE TIME.
The RISE time function is switched ON via the softkey RISE TIME.

4 2 1 1 10%-90%

After pushing softkey 10%-90%, the RISE TIME will be measured from 10% till 90% of the amplitude rise between the cursors.

4 2 1 2 20%-80%

After pushing softkey 20%-80%, the RISE TIME will be measured from 20% till 80% of the amplitude rise between the cursors.

4 2 1 3 VAR (Variable)

After pushing softkey VAR, variable RISE TIME limits can be selected by softkeys 4...7 for which the text is now displayed.
The selected limits are displayed between the softkey text of the softkeys 4 and 5.
RISE TIME is measured from the BEGIN value to the END values.

4 2 1 4 BEGIN END

This softkey text becomes visible after pushing softkey VAR.
This softkey has a toggle function. With this softkey, a selection is made between changing the BEGIN or the END function.
The active state is displayed intensified.
The values of BEGIN and END are displayed directly below the correspondending softkey text.

4 2 1 5 UP

This softkey text becomes visible after pushing softkey VAR.
Pushing this softkey, results in an increment of the BEGIN or END value, whichever is selected by softkey 4.
The increment itself is selectable by softkey 7.

4 2 1 6 DOWN

This softkey text becomes visible after pushing softkey VAR.
Pushing this softkey, results in a decrement of the BEGIN or END value, whichever is selected by softkey 4.
The decrement itself is selectable by softkey 7.

4 2 1 7 10% 1%

This softkey text becomes visible after pushing softkey VAR.
With this softkey, the increment or decrement is selected for the UP or DOWN softkeys 5 or 6.

4 2 1 8 RETURN

After pushing softkey RETURN, the MEASURE TIME menu is displayed again. The selections as made before remain unchanged.

4 2 2 RISE TIME

If RISE is selected, the RISE time is calculated for the limits set via the RISE LIMIT menu.
The result is displayed in the bottom of the graticule.

4 2 3 FREQUENCY

After pushing FREQUENCY, the FREQUENCY value is calculated as follows.
The MEAN value of the signal detail between the cursors is calculated. From the time difference between the first and the third crossing with this MEAN value the FREQUENCY is calculated.

4 2 4 --

4 2 5 PULS WIDTH

After pushing PULS WIDTH, the PULS WIDTH value is calculated as follows.
The value in the middle between the PEAK-PEAK values is the level where PULS WIDTH is measured.
PULS WIDTH is the time difference between the first and second crossing of the above level.

4 2 6 DUTY CYCLE

After pushing DUTY CYCLE, the DUTY CYCLE value is calculated as followed.
The MEAN value of the signal detail between the cursors is calculated. From the time difference between the first and third crossing with this MEAN value the period time is calculated.
The time difference between the first and second crossing divided by the period time determines the DUTY CYCLE.

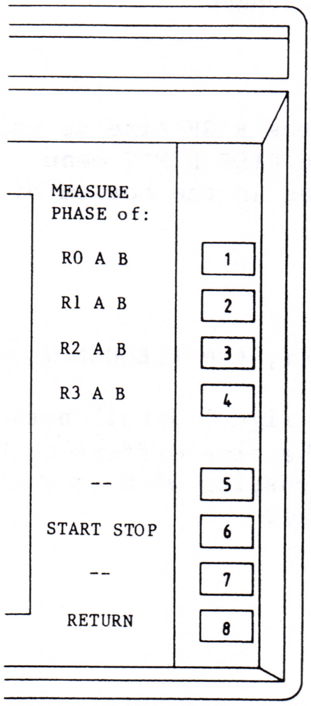
4 2 7 MARKERS

If MARKERS is selected, The markers become visible on the trace that is selected for the cursors.
The MARKERS will indicate the measurement positions of the active TIME measurement that has the highest position in the TIME menu.

4 2 8 RETURN

After pushing softkey RETURN, the CURSOR MEASURE menu will be visible again.
The results of the selected measurements are still displayed.

4 3 PHASE>



If PHASE is selected, the MEASURE PHASE menu is displayed and a selection can be made between all registers that contain two channels.
If there are no two channel registers, PHASE can not be selected and is not visible.
Each valid softkey has a toggle function after it is selected. With this toggle function, the channel can be selected that is used as reference.
From this channel, the period time is determined. From both channels, the MEAN level is determined.
PHASE is the time difference between the first crossings of the two channel signals and their MEAN level, divided by the reference period and expressed in degrees.
The result is displayed in the measurement result text area (see section 4.2.2.2).
The PHASE measurement is started by toggling softkey 6, START STOP.

4 3 1 R0 A B

4 3 2 R1 A B

4 3 3 R2 A B

4 3 4 R3 A B

After pushing one of these softkeys, the selected register is used for measurement of the PHASE between the channel present in this register.

4 3 5 --

4 3 6 START STOP

After pushing softkey START STOP, the PHASE measurement is started and the result becomes visible.
This softkey has a toggle function so pushing it again will stop the measurement.

4 3 7 --

4 3 8 RETURN

After pushing softkey RETURN, the CURSOR MEASURE menu will visible again.
The result of the selected measurement are still displayed.

4 4 dt 1/dt

By pushing this softkey, a selection is made for the representation of the horizontal distance between the cursors.
In dt mode, the value is expressed in seconds.
In 1/dt mode, the value is expressed in hertz.
The result is displayed in the top text area.
If both cursors are positioned on exactly the same position the result will display 1/dt:1/ 0/d.

4 5 CURSORS at PERIOD

After pushing CURSORS at PERIOD, the cursors are placed at the first and third zero crossing of the channel in which the first cursor was situated and the period is measured.
If this period is not found, the cursors are placed on the channel where the second cursor was.
If here also no period is found, an error message is given.

4 6 GROUND IND

By pushing GROUND IND the zero lines of the channels selected for the cursors, is displayed.
The ground level is indicated by, ten (10) lines between the vertical graticule lines, for the channel with the left cursor and by nine (9) lines on the vertical graticule lines for the channel with the right cursor.

4 7 INCL OFFST

After pushing softkey INCL OFFST, the OFFST defined earlier is included in the measurement.

4 8 RETURN

After pushing softkey RETURN, the CURSOR SELECT menu becomes visible.

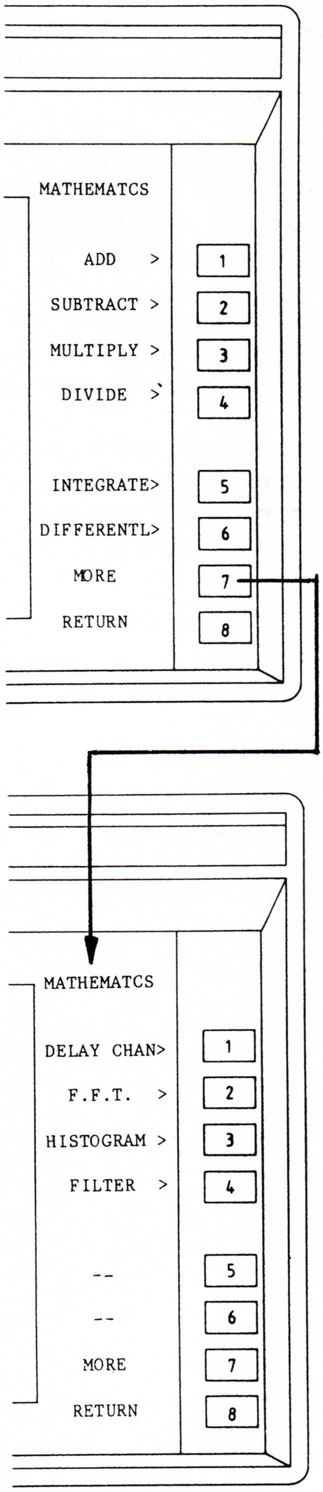
5 CALIBRATE

After pushing softkey CALIBRATE, the main processor will build up or correct an array of correction factors for ground, shift and offset.
This array will contain:

- The real ground levels for channels A and B, in single channel mode with offset and shift at zero, measured at time bases 2 ms/div, 2 us/div and 100 ns/div.
- The real ground levels for channels A and B, in dual channel mode with offset and shift at zero, measured at time bases 2 ms/div, 2 us/div and 100 ns/div.
- Shift correction at four divisions for channels A and B.
- Offset correction at four divisions for channels A and B.

These figures are measured with the inputs to ground, in recurrent and auto triggered.
After the calibration procedure is completed, the oscilloscope returns to the situation as before the calibration was started.

6 MATHEMATCS>



MATHEMATCS is selected, the MATHEMATCS menu becomes visible and a number of mathematical functions can be selected.
Because of the number of mathematical operations exceeds the number of softkeys, a MORE function is introduced to be able to select more functions on this same menu level. A selection in this MATHEMATICS 'MORE' menu is indicated with the numbers 7,1 ... 7,8, where 7, indicates softkey 7 in the first MATHEMATCS menu.

ADD, SUBTRACT, MULTIPLY and DIVIDE are so called type 1 operations that need two source channels (CH1 and CH2). These traces can have different length. Therefore they are expanded over 4096 points with linear interpolated points inbetween. So the operation is always over 4096 points.

The type 2 operations INTEGRATE, DIFFERENTL, FFT and HYSTOGRAM always operate on the real resolution. The result is then expanded over 4096 points with linear interpolated points inbetween.

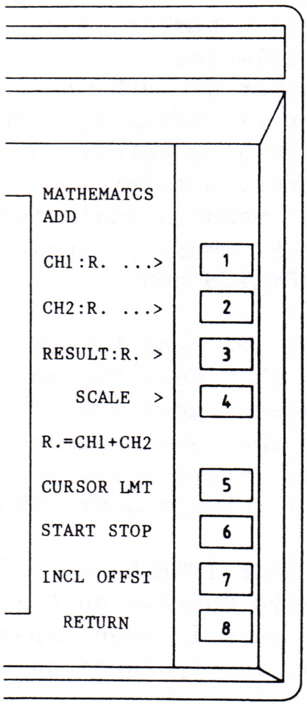
The result can be scaled with a selected value. The amplitude and time indications are updated to give the actual values.

The function is started by pressing START STOP in the selected function menu. It is stopped by pressing START STOP again or by starting another mathematical function.
The operations are restarted if the sources are from the registers R1, R2 or R3, a save action takes place and the operation still is active.
If the source is from R0, the operation is continuously restarted.

If there are no registers active that contain two channels the function DELAY CHAN will not be visible

The selection of SOURCE, RESULT or SCALE for any of the mathematic functions is valid for all other mathematic functions.

6 1 ADD>

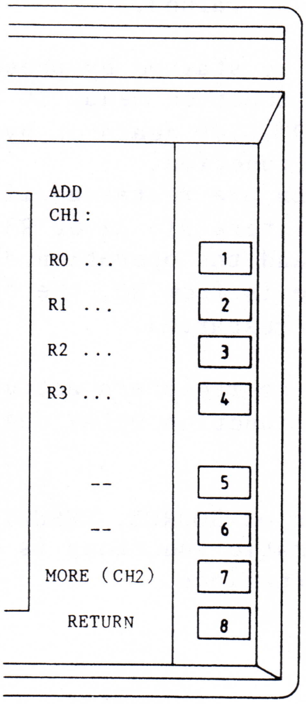


If ADD is selected, the MATHEMATCS ADD menu becomes visible and the sources and destination can be selected.

Note: A change in the parameters of the ADD function will also change the parameters of all other functions, including any active one.

Selecting START (softkey 6) will automatically switch OFF any active MATHEMATCS function and start the ADD function.
CURSOR LMT results in the addition of the part between the cursors.
When one of the sources is updated, the result register is also updated.

6 1 1 CH1:R. ...>



If CH1:R. ... is selected, the CH1 menu becomes visible and channel 1 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6	1	1	1	R0 ...
6	1	1	2	R1 ...
6	1	1	3	R2 ...
6	1	1	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH1.
If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

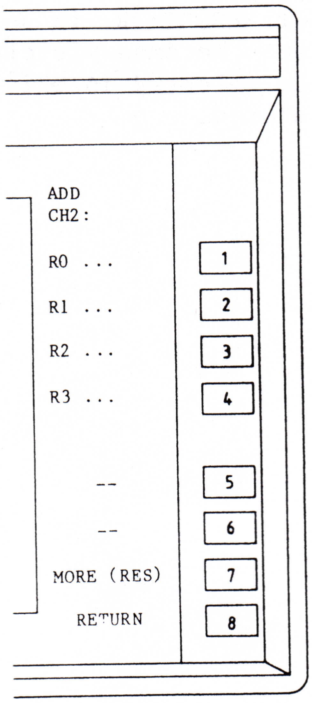
6	1	1	5	--
6	1	1	6	--
6	1	1	7	MORE (CH2)

If MORE (CH2) is pressed, the CURSOR CH2 menu will appear. MORE (CH2) has the same result as pressing RETURN and selecting CH2:R. ...

6	1	1	8	RETURN

After pushing softkey RETURN, the MATHEMATCS ADD menu becomes visible.

6	1	2	CH2:R. ...>



If CH2:R. ... is selected, the CH2 menu becomes visible and channel 2 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6	1	2	1	R0 ...
6	1	2	2	R1 ...
6	1	2	3	R2 ...
6	1	2	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH2.
If two channels are present in the selected register, then pressing the softkey again will result in toggling between the two channels in the register.

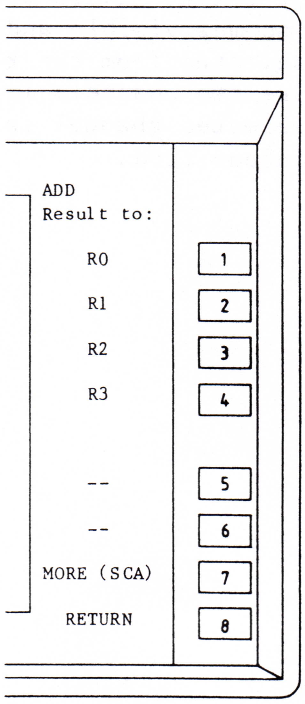
6	1	2	5	--
6	1	2	6	--
6	1	2	7	MORE (RES)

If MORE (RES) is pressed, the RESULT R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT R..

6 1 2 8 RETURN

After pushing softkey RETURN, the MATHEMATCS ADD menu becomes visible.

6 1 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6	1	3	1	R0
6	1	3	2	R1
6	1	3	3	R2
6	1	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

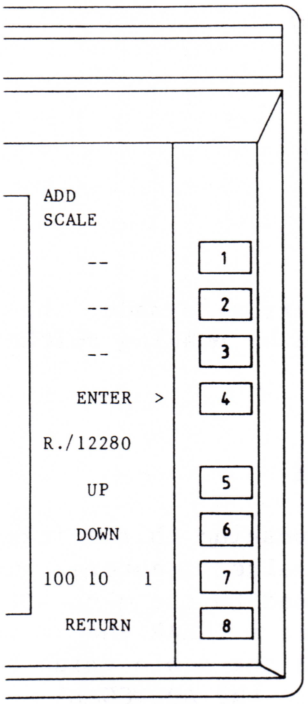
6	1	3	5	--
6	1	3	6	--
6	1	3	7	MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6	1	3	8	RETURN

After pushing softkey RETURN, the MATHEMATCS ADD menu becomes visible.

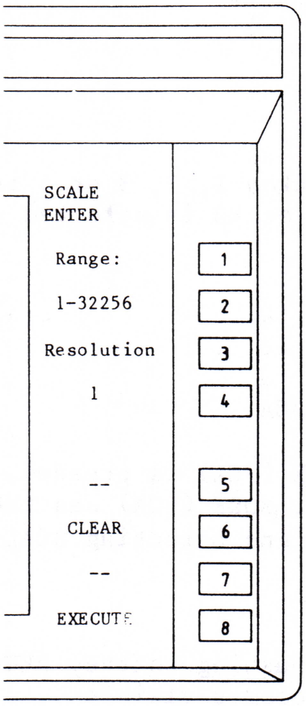
6	1	4	SCALE>



If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS ADD operation inside the vertical register range.

6	1	4	1	--
6	1	4	2	--
6	1	4	3	--

6 1 4 4 ENTER>



After selecting ENTER, the ADD SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6 1 4 4 1 --

6 1 4 4 2 --

6 1 4 4 3 --

6 1 4 4 4 --

6 1 4 4 5 --

6 1 4 4 6 CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6 1 4 4 7 --

6 1 4 4 8 EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu ADD SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the ADD SCALE menu.

A message

ADD SCALE number out of range

is displayed if the entered value exceeds the given range.

6 1 4 5 UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6 1 4 6 DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6 1 4 7 100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6 1 4 8 RETURN

After pushing softkey RETURN, the MATHEMATCS ADD menu becomes visible.

6 1 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS ADD function is performed on the channels between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH1.
When the function is active CURSOR LMT is displayed intensified.

6 1 6 START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS ADD operation. The actual state is displayed intensified.
START will stop any other active MATHEMATCS function.

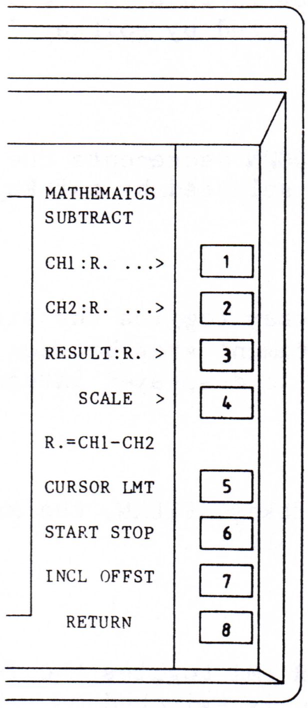
6 1 7 INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channels being included in the MATHEMATCS ADD operation. When the function is active, INCL OFFST is displayed intensified.

6 1 8 RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6 2 SUBTRACT>

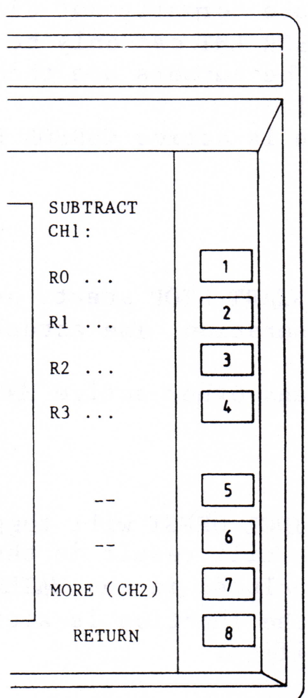


If SUBTRACT is selected, the MATHEMATCS SUBTRACT menu becomes visible and the sources and destination can be selected.

Note: A change in the parameters of the SUBTRACT function will also change the parameters of all other functions, including any active one.

Selecting START (softkey 6) will automatically switch OFF any active MATHEMATCS function and start the SUBTRACT function.
CURSOR LMT results in the subtraction of the part between the cursors.
When one of the sources is updated, the result register is also updated.

6 2 1 CH1:R. ...>



If CH1:R. ... is selected, the CH1 menu becomes visible and channel 1 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6	2	1	1	R0 ...
6	2	1	2	R1 ...
6	2	1	3	R2 ...
6	2	1	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH1.
If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

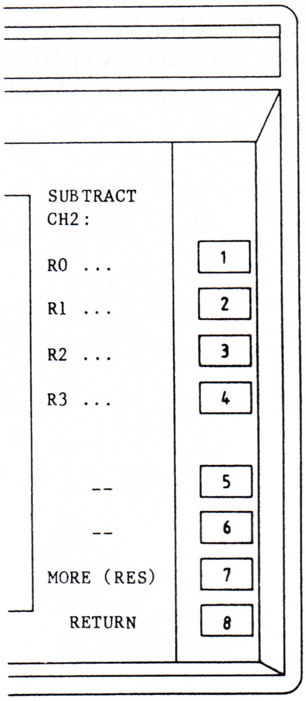
6	2	1	5	--
6	2	1	6	--
6	2	1	7	MORE (CH2)

If MORE (CH2) is pressed, the CURSOR CH2 menu will appear. MORE (CH2) has the same result as pressing RETURN and selecting CH2:R. ...

6 2 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS SUBTRACT menu becomes visible.

6 2 2 CH2:R. ...>



If CH2:R. ... is selected, the CH2 menu becomes visible and channel 2 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6 2 2 1 R0 ...

6 2 2 2 R1 ...

6 2 2 3 R2 ...

6 2 2 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH2.
If two channels are present in the selected register, then pressing the softkey again will result in toggling between the two channels in the register.

6 2 2 5 --

6 2 2 6 --

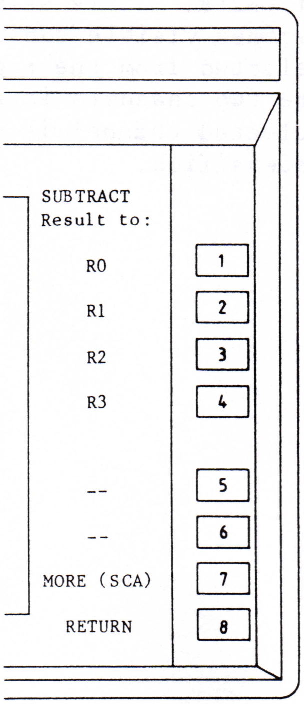
6 2 2 7 MORE (RES)

If MORE (RES) is pressed, the RESULT R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT R..

6 2 2 8 RETURN

After pushing softkey RETURN, the MATHEMATCS SUBTRACT menu becomes visible.

6 2 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6 2 3 1 R0

6 2 3 2 R1

6 2 3 3 R2

6 2 3 4 R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6 2 3 5 --

6 2 3 6 --

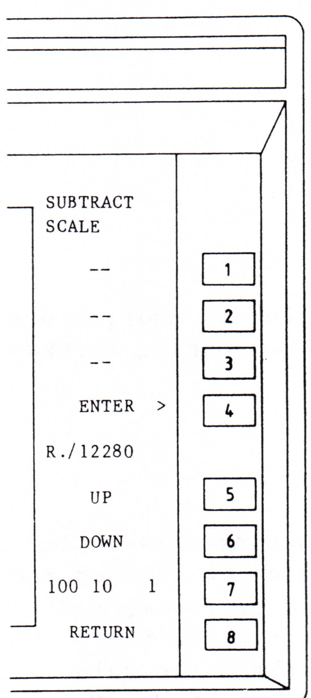
6 2 3 7 MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6 2 3 8 RETURN

After pushing softkey RETURN, the MATHEMATCS SUBTRACT menu becomes visible.

6 2 4 SCALE>



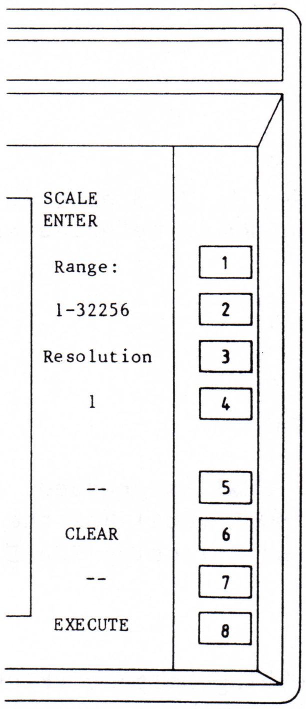
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS SUBTRACT operation inside the vertical register range.

6 2 4 1 --

6 2 4 2 --

6 2 4 3 --

6 2 4 4 ENTER>



After selecting ENTER, the SUBTRACT SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6 2 4 4 1 --

6 2 4 4 2 --

6 2 4 4 3 --

6 2 4 4 4 --

6 2 4 4 5 --

6 2 4 4 6 CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6 2 4 4 7 --

6 2 4 4 8 EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu SUBTRACT SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the SUBTRACT SCALE menu.

A message

SUBTRACT SCALE number out of range

can be displayed if the entered value exceeds the given range.

6 2 4 5 UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6 2 4 6 DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6 2 4 7 100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6 2 4 8 RETURN

After pushing softkey RETURN, the MATHEMATCS SUBTRACT menu becomes visible.

6 2 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS SUBTRACT function is performed on the channels between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH1.
When the function is active CURSOR LMT is displayed intensified.

6 2 6 START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS SUBTRACT operation. The actual state is displayed intensified.
START will stop any other active MATHEMATCS function.

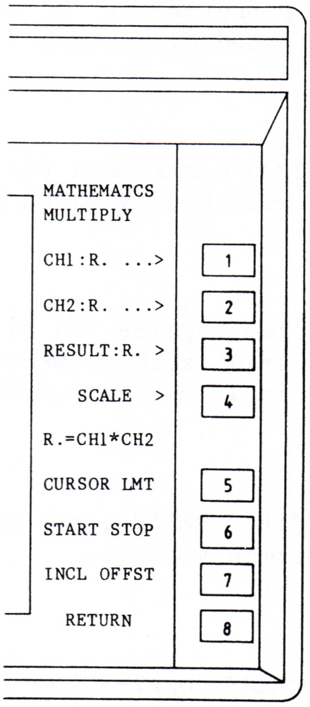
6 2 7 INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channels being included in the MATHEMATCS SUBTRACT operation. When the function is active, INCL OFFST is displayed intensified.

6 2 8 RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6 3 MULTIPLY

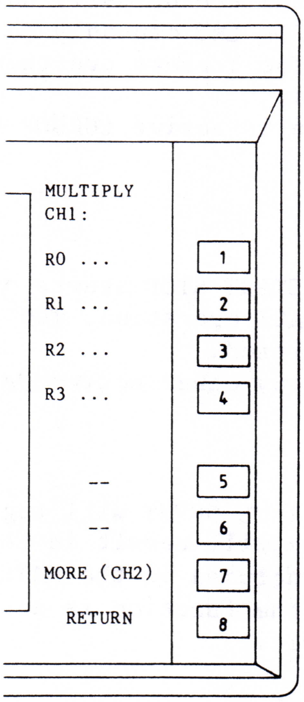


If MULTIPLY is selected, the MATHEMATCS MULTIPLY menu becomes visible and the sources and destination can be selected.

Note: A change in the parameters of the MULTIPLY function will also change the parameters of all other functions, including any active one.

Selecting START (softkey 6) will automatically switch OFF any active MATHEMATCS function and start the MULTIPLY function.
CURSOR LMT results in the multiplication of the part between the cursors.
When one of the sources is updated, the result register is also updated.

6 3 1 CH1:R. ...>



If CH1:R. ... is selected, the CH1 menu becomes visible and channel 1 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6	3	1	1	R0 ...
6	3	1	2	R1 ...
6	3	1	3	R2 ...
6	3	1	4	R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH1. If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

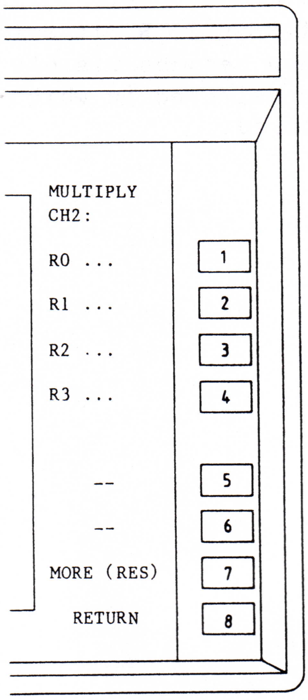
6	3	1	5	--
6	3	1	6	--
6	3	1	7	MORE (CH2)

If MORE (CH2) is pressed, the CURSOR CH2 menu will appear. MORE (CH2) has the same result as pressing RETURN and selecting CH2:R. ...

6 3 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS MULTIPLY menu becomes visible.

6 3 2 CH2:R. ...>



If CH2:R. ... is selected, the CH2 menu becomes visible and channel 2 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6 3 2 1 R0 ...

6 3 2 2 R1 ...

6 3 2 3 R2 ...

6 3 2 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH2.
If two channels are present in the selected register, then pressing the softkey again will result in toggling between the two channels in the register.

6 3 2 5 --

6 3 2 6 --

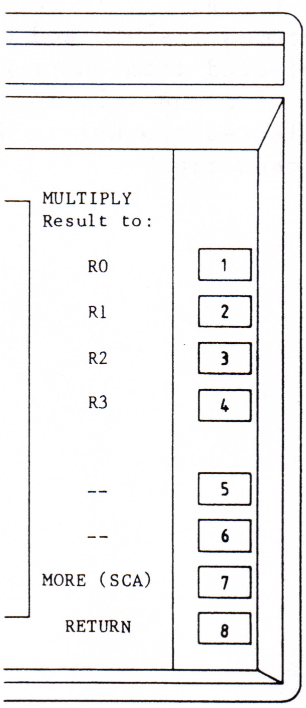
6 3 2 7 MORE (RES)

If MORE (RES) is pressed, the RESULT R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT R..

6 3 2 8 RETURN

After pushing softkey RETURN, the MATHEMATCS MULTIPLY menu becomes visible.

6 3 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6 3 3 1 R0

6 3 3 2 R1

6 3 3 3 R2

6 3 3 4 R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6 3 3 5 --

6 3 3 6 --

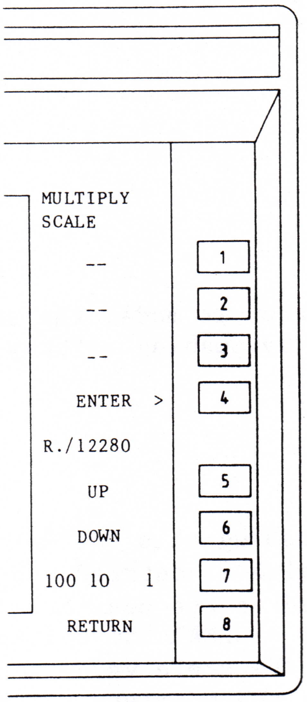
6 3 3 7 MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6 3 3 8 RETURN

After pushing softkey RETURN, the MATHEMATCS MULTIPLY menu becomes visible.

6 3 4 SCALE>



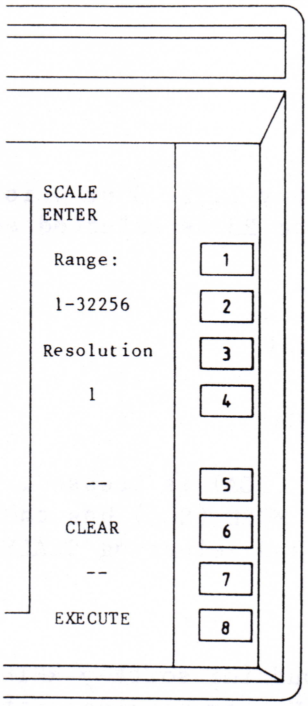
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS MULTIPLY operation inside the vertical register range.

6 3 4 1 --

6 3 4 2 --

6 3 4 3 --

6 3 4 4 ENTER>



After selecting ENTER, the MULTIPLY SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6 3 4 4 1 --

6 3 4 4 2 --

6 3 4 4 3 --

6 3 4 4 4 --

6 3 4 4 5 --

6 3 4 4 6 CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6 3 4 4 7 --

6 3 4 4 8 EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu MULTIPLY SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the MULTIPLY SCALE menu.

A message

MULTIPLY SCALE number out of range

is displayed if the entered value exceeds the given range.

6 3 4 5 UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6 3 4 6 DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6 3 4 7 100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6 3 4 8 RETURN

After pushing softkey RETURN, the MATHEMATCS MULTIPLY menu becomes visible.

6 3 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS MULTIPLY function is performed on the channels between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH1.
When the function is active CURSOR LMT is displayed intensified.

6 3 6 START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS MULTIPLY operation. The actual state is displayed intensified.
START will stop any other active MATHEMATCS function.

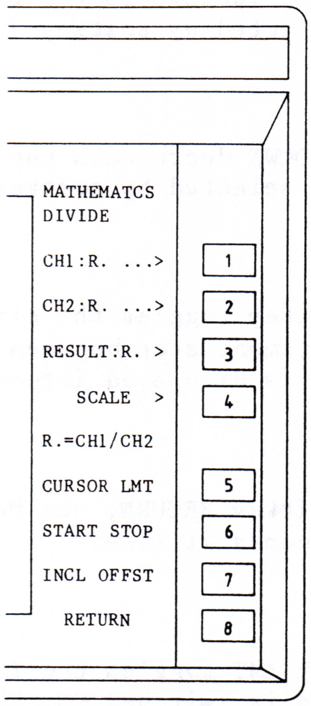
6 3 7 INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channels being included in the MATHEMATCS MULTIPLY operation. When the function is active, INCL OFFST is displayed intensified.

6 3 8 RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6 4 DIVIDE>

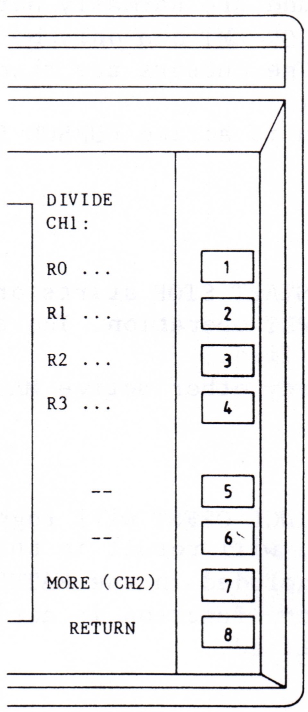


If DIVIDE is selected, the MATHEMATCS DIVIDE menu becomes visible and the sources and destination can be selected.

Note: A change in the parameters of the DIVIDE function will also change the parameters of all other functions, including any active one.

Selecting START (softkey 6) will automatically switch OFF any active MATHEMATCS function and start the DIVIDE function.
CURSOR LMT results in the division of the part between the cursors.
When one of the sources is updated, the result register is also updated.

6 4 1 CH1:R. ...>



If CH1:R. ... is selected, the CH1 menu becomes visible and channel 1 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6 4 1 1 R0 ...

6 4 1 2 R1 ...

6 4 1 3 R2 ...

6 4 1 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH1.
If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

6 4 1 5 --

6 4 1 6 --

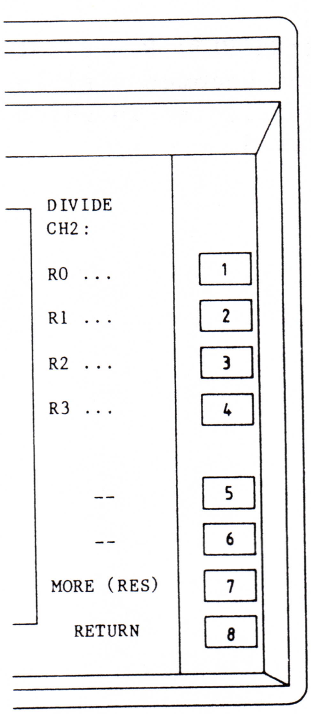
6 4 1 7 MORE (CH2)

If MORE (CH2) is pressed, the CURSOR CH2 menu will appear. MORE (CH2) has the same result as pressing RETURN and selecting CH2:R. ...

6 4 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DIVIDE menu becomes visible.

6 4 2 CH2:R. ...>



If CH2:R. ... is selected, the CH2 menu becomes visible and channel 2 can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6 4 2 1 R0 ...

6 4 2 2 R1 ...

6 4 2 3 R2 ...

6 4 2 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH2. If two channels are present in the selected register, then pressing the softkey again will result in toggling between the two channels in the register.

6 4 2 5 --

6 4 2 6 --

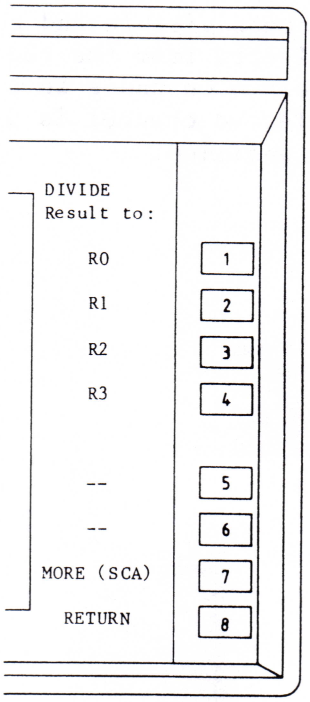
6 4 2 7 MORE (RES)

If MORE (RES) is pressed, the RESULT R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT R..

6 4 2 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DIVIDE menu becomes visible.

6 4 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6 4 3 1 R0

6 4 3 2 R1

6 4 3 3 R2

6 4 3 4 R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6 4 3 5 --

6 4 3 6 --

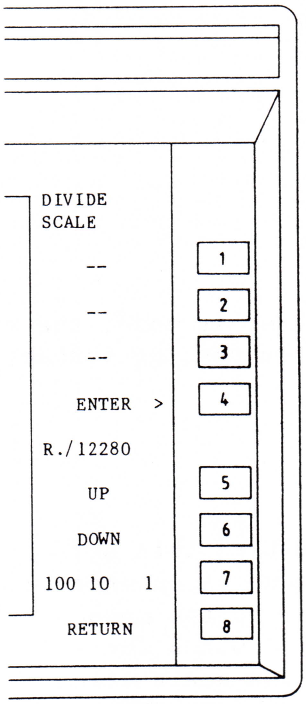
6 4 3 7 MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6 4 3 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DIVIDE menu becomes visible.

6 4 4 SCALE>



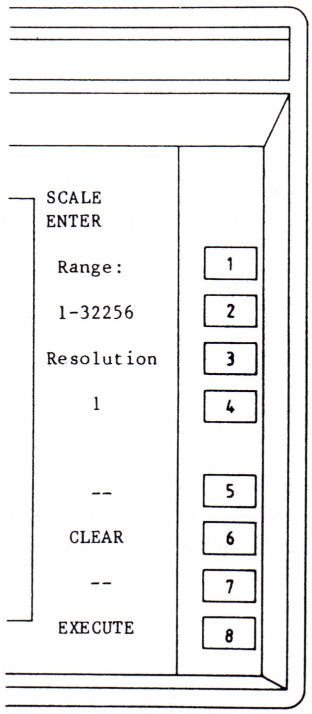
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS DIVIDE operation inside the vertical register range.

6 4 4 1 --

6 4 4 2 --

6 4 4 3 --

6 4 4 4 ENTER>



After selecting ENTER, the DIVIDE SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6 4 4 4 1 --

6 4 4 4 2 --

6 4 4 4 3 --

6 4 4 4 4 --

6 4 4 4 5 --

6 4 4 4 6 CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6 4 4 4 7 --

6 4 4 4 8 EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu DIVIDE SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the DIVIDE SCALE menu.

A message

DIVIDE SCALE number out of range

is displayed if the entered value exceeds the given range.

6 4 4 5 UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6 4 4 6 DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6 4 4 7 100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6 4 4 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DIVIDE menu becomes visible.

6 4 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS DIVIDE function is performed on the channels between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH1.
When the function is active CURSOR LMT is displayed intensified.

6 4 6 START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS DIVIDE operation. The actual state is displayed intensified.
START will stop any other active MATHEMATCS function.

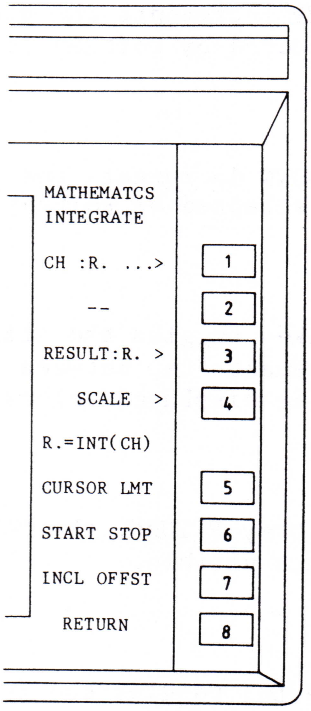
6 4 7 INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channels being included in the MATHEMATCS DIVIDE operation. When the function is active, INCL OFFST is displayed intensified.

6 4 8 RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6 5 INTEGRATE>

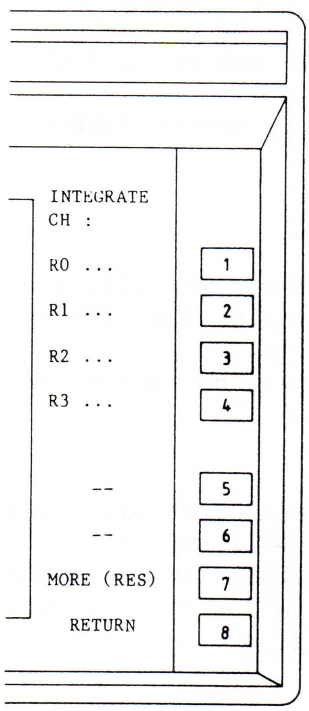


If INTEGRATE is selected, the MATHEMATCS INTEGRATE menu becomes visible and the source and destination can be selected.

Note: A change in the parameters of the INTEGRATE function will also change the parameters of all other functions, including any active one.

Selecting START (softkey 6) will automatically switch OFF any active MATHEMATCS function and start the INTEGRATE function.
CURSOR LMT results in the integratton of the part between the cursors.
When the source is updated, the result register is also updated.

6 5 1 CH :R. ...>



If CH :R. ... is selected, the CH menu becomes visible and the source channel can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6 5 1 1 R0 ...

6 5 1 2 R1 ...

6 5 1 3 R2 ...

6 5 1 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH.
If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

6 5 1 5 --

6 5 1 6 --

6 5 1 7 MORE (RES)

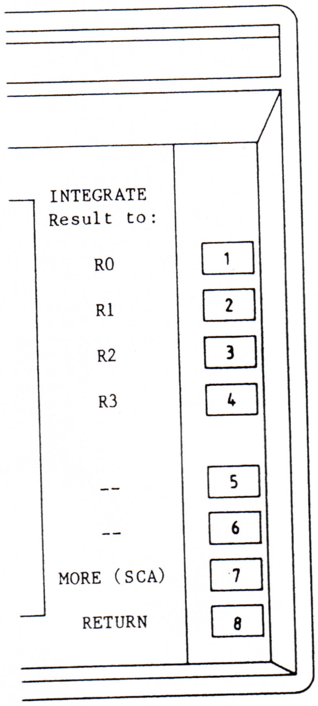
If MORE (RES) is pressed, the RESULT:R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT:R.

6 5 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS INTEGRATE menu becomes visible.

6 5 2 --

6 5 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6	5	3	1	R0
6	5	3	2	R1
6	5	3	3	R2
6	5	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

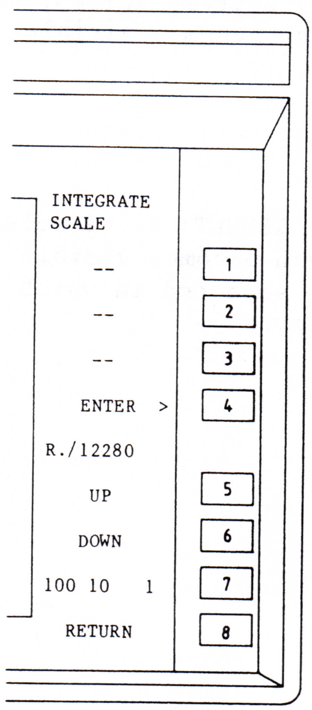
6	5	3	5	--
6	5	3	6	--
6	5	3	7	MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6 5 3 8 RETURN

After pushing softkey RETURN, the MATHEMATCS INTEGRATE menu becomes visible.

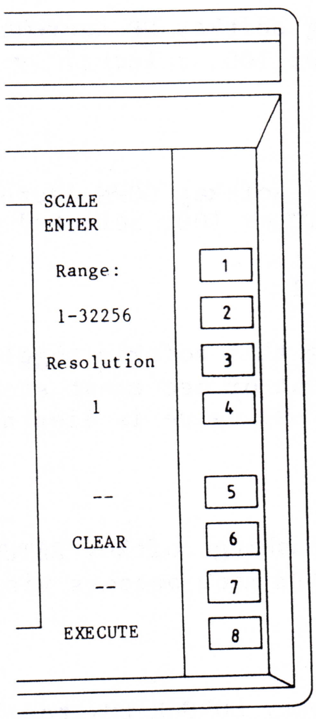
6 5 4 SCALE>



If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS INTEGRATE operation inside the vertical register range.

6	5	4	1	--
6	5	4	2	--
6	5	4	3	--

6 5 4 4 ENTER>



After selecting ENTER, the INTEGRATE SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6 5 4 4 1 --

6 5 4 4 2 --

6 5 4 4 3 --

6 5 4 4 4 --

6 5 4 4 5 --

6 5 4 4 6 CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6 5 4 4 7 --

6 5 4 4 8 EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu INTEGRATE SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the INTEGRATE SCALE menu.

A message

INTEGRATE SCALE number out of range

is displayed if the entered value exceeds the given range.

6 5 4 5 UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6 5 4 6 DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6 5 4 7 100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6 5 4 8 RETURN

After pushing softkey RETURN, the MATHEMATCS INTEGRATE menu becomes visible.

6 5 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS INTEGRATE function is performed on the channel between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH.
When the function is active CURSOR LMT is displayed intensified.

6 5 6 START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS INTEGRATE operation. The actual state is displayed intensified.

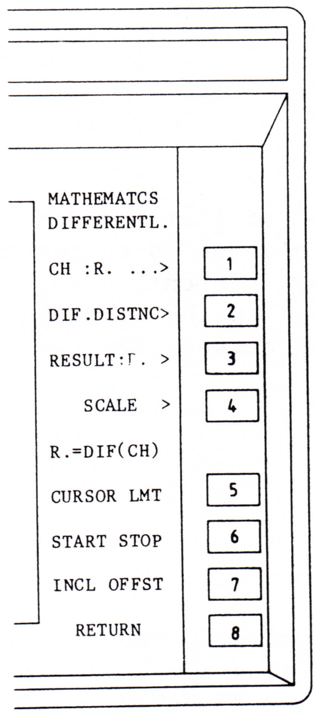
6 5 7 INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channel being included in the MATHEMATCS INTEGRATE operation. When the function is active, INCL OFFST is displayed intensified.

6 5 8 RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6 6 DIFFERENTL>



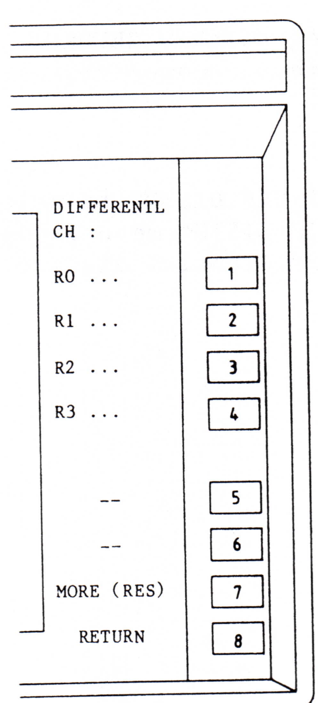
If DIFFERENTL is selected, the MATHEMATCS DIFFERENTL menu becomes visible and the source and destination can be selected. The differentiation formula is:

DIF(i) = point (i+n) - point (i-n)

Where i is the differentiated point and n is the differentiation distance.

At the begin and end of the channel 64 points are extra-polated by rotating the first 64 points 180 degrees around point 0 and the last 64 points 180 degrees around point 4095.

6 6 1 CH :R. ...>



If CH :R. ... is selected, the CH menu becomes visible and the source CH can be selected from the registers. If there are two channels in a register, the selected channel is displayed intensified.

6 6 1 1 R0 ...

6 6 1 2 R1 ...

6 6 1 3 R2 ...

6 6 1 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH.
If two channels are present in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

6 6 1 5 --

6 6 1 6 --

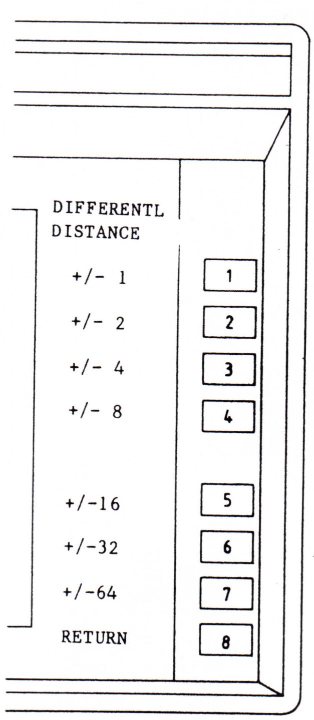
6 6 1 7 MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT:R.

6 6 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DIFFERENTL menu becomes visible.

6 6 2 DIF.DISTNC>



If DIF.DISTNC is selected, the DIF.DISTNC menu becomes visible and the differential distance is selected.

6 6 2 1 +/- 1

6 6 2 2 +/- 2

6 6 2 3 +/- 4

6 6 2 4 +/- 8

6 6 2 5 +/- 16

6 6 2 6 +/- 32

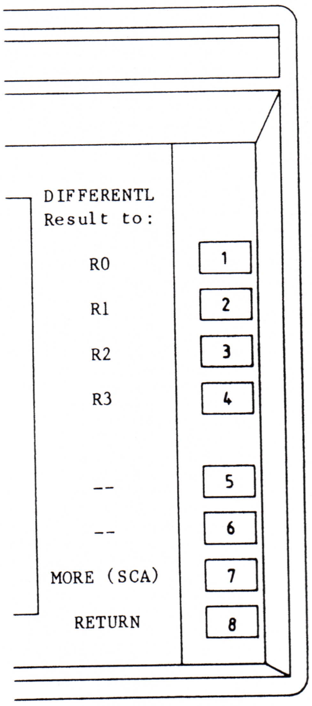
6 6 2 7 +/- 64

These softkeys select the differential distance used for the MATHEMATCS DIFFERENTL operation. The default value is +/- 1.

6 6 2 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DIFFERENTL menu becomes visible.

6 6 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6 6 3 1 R0

6 6 3 2 R1

6 6 3 3 R2

6 6 3 4 R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6 6 3 5 --

6 6 3 6 --

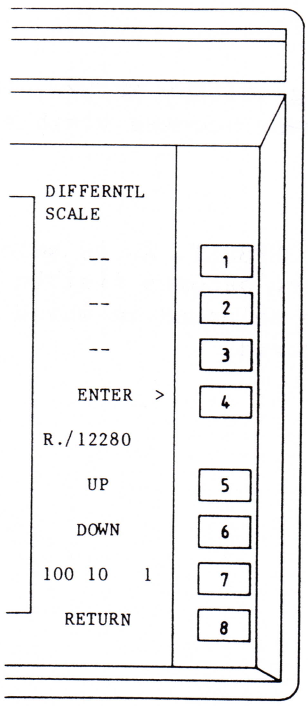
6 6 3 7 MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6 6 3 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DIFFERENTL menu becomes visible.

6 6 4 SCALE>



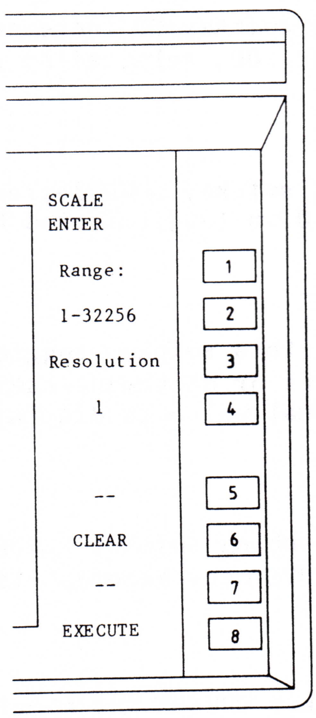
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS DIFFERENTL operation inside the vertical register range.

6 6 4 1 --

6 6 4 2 --

6 6 4 3 --

6 6 4 4 ENTER>



After selecting ENTER, the DIFFERENTL SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6 6 4 4 1 --

6 6 4 4 2 --

6 6 4 4 3 --

6 6 4 4 4 --

6 6 4 4 5 --

6 6 4 4 6 CLEAR

If an error is made, the scale value can be cleared by pushing softkey CLEAR.

6 6 4 4 7 --

6 6 4 4 8 EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu DIFFERENTL SCALE.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the DIFFERENTL SCALE menu.

A message

DIFFERENTL SCALE number out of range

is displayed if the entered value exceeds the given range.

6 6 4 5 UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6 6 4 6 DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

6 6 4 7 100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6 6 4 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DIFFERENTL menu becomes visible.

6 6 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function ON or OFF. When the function is switched ON, the MATHEMATCS DIFFERENTL function is performed on the channel between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH.
When the function is active CURSOR LMT is displayed intensified.

6 6 6 START STOP

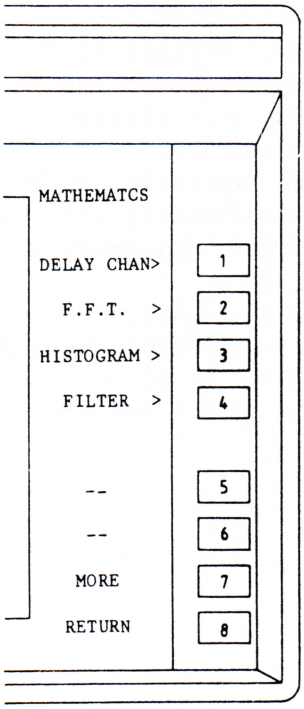
Pushing softkey START STOP starts or stops the MATHEMATCS DIFFERENTL operation. The actual state is displayed intensified.

6 6 7 INCL OFFST
Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the channel being included in the MATHEMATCS DIFFERENTL operation. When the function is active, INCL OFFST is displayed intensified.

6 6 8 RETURN

After pushing RETURN, the MATHEMATCS menu becomes visible.

6 7 MORE

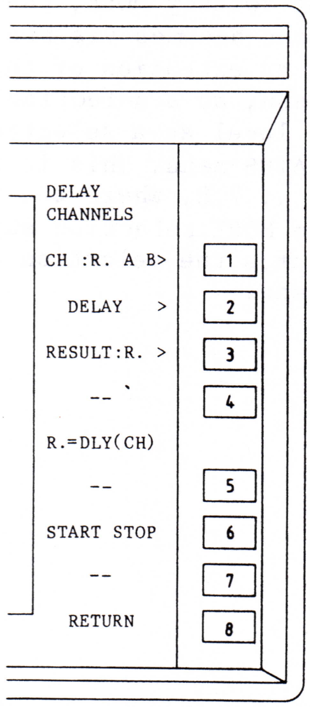


After pushing softkey MORE, the second MATHEMATCS menu becomes visible.
This menu is an extension of the first MATHEMATCS menu, so a selection in this menu has the same level as a selection in the first MATHEMATCS menu. This is indicated by numbers 7,1 ... 7,8, where the first number indicates the MORE selection and the second number indicates the selection in the second MATHEMATCS menu.

6 8 RETURN

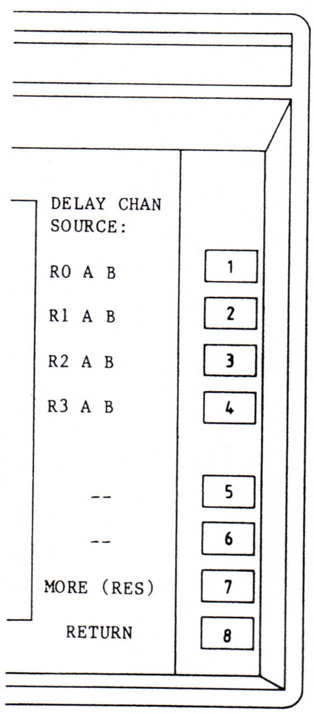
After pushing RETURN, the CURSOR SELECT menu becomes visible.

6 7,1 DELAY CHAN>



If DELAY CHAN is selected, the MATHEMATCS DELAY CHAN menu becomes visible and the sources and destination can be selected. DELAY CHAN can only operate on registers that contain two channels.
The DELAY CHAN operation will shift in time, one of the two channels with the selected delay. The channel to shift is selected in the sub-menu DELAY.
The dots that are shifted out of a register are lost and can not be recalled. The dots that are shifted in on the other side are put on the minimum level and are indicated as not real samples.

6 7,1 1 CH :R. A B>



If CH :R. A B is selected, the CH menu becomes visible and the source channel can be selected from the registers. Only registers in which two channels are present can be selected.

6 7,1 1 1 R0 A B

6 7,1 1 2 R1 A B

6 7,1 1 3 R2 A B

6 7,1 1 4 R3 A B

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH.
Only registers that contain two channels will be displayed and can be selected.

6 7,1 1 5 --

6 7,1 1 6 --

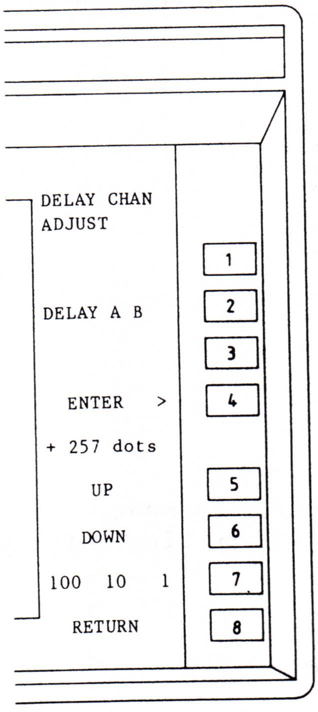
6 7,1 1 7 MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will appear. MORE (RES) has the same result as pressing the RETURN and then selecting RESULT:R.

6 7,1 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS DELAY CHAN menu becomes visible.

6 7,1 2 DELAY>



If DELAY is selected, the DELAY CHAN ADJUST menu becomes visible. In this menu the channel can be selected, that has to be delayed and the delay can be entered or changed.

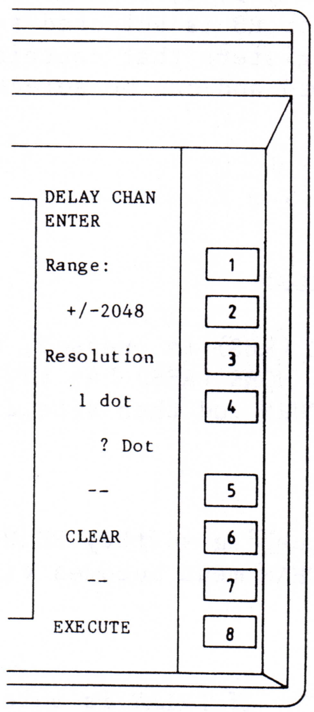
6 7,1 2 1 --

6 7,1 2 2 DELAY A B

If DELAY A B is pressed, the channel to delay is toggled between A and B. The selected channel is displayed intensified.

6 7,1 2 3 --

6 7,1 2 4 ENTER>



After selecting ENTER, the DELAY ENTER menu will be displayed and the delay can be selected with the numeric keyboard. The actual range and the value is visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6 7,1 2 4 1 --

6 7,1 2 4 2 --

6 7,1 2 4 3 --

6 7,1 2 4 4 --

6 7,1 2 4 5 --

6 7,1 2 4 6 CLEAR

If an error is made, the delay value can be cleared by pushing softkey CLEAR.

6 7,1 2 4 7 --

6 7,1 2 4 8 EXECUTE

After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu DELAY CHAN ADJUST.
If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the DELAY CHANNEL ADJUST menu.

A message

DELAY CHANNEL ADJUST number out of range

is displayed if the entered value exceeds the given range.

6	7,1	2	5	UP

Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.

6	7,1	2	6	DOWN

Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.

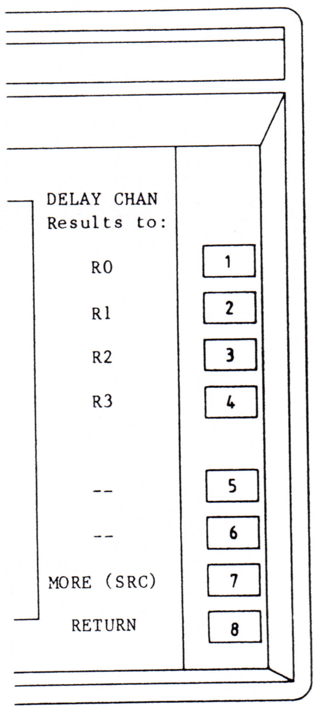
6	7,1	2	7	100 10 1

Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.

6	7,1	2	8	RETURN

After pushing softkey RETURN, the DELAY CHANNELS menu becomes visible.

6	7,1	3	RESULT: R.>



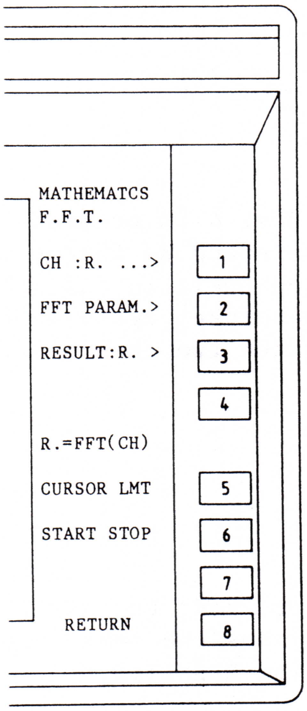
If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6	7,1	3	1	R0
6	7,1	3	2	R1
6	7,1	3	3	R2
6	7,1	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

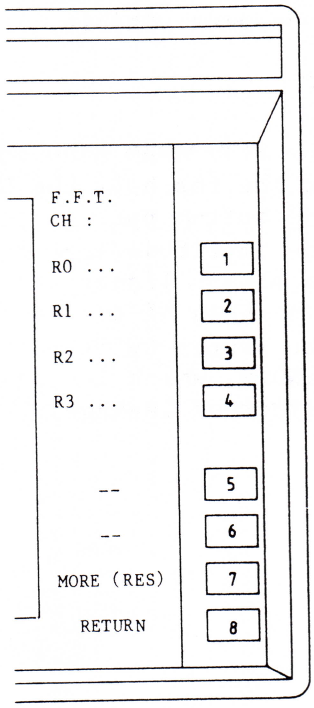
6	7,1	3	5	--
6	7,1	3	6	--
6	7,1	3	7	MORE (SRC) If MORE (SRC) is pressed, the CH :R. A B menu will appear. MORE (SRC) has the same result as pressing RETURN and then selecting CH :R. A B
6	7,1	3	8	RETURN After pushing softkey RETURN, the MATHEMATCS DELAY CHAN menu becomes visible.
6	7,1	4	--	
6	7,1	5	--	
6	7,1	6	START STOP Pushing softkey START STOP starts or stops the DELAY CHAN operation. The actual state is displayed intensified.	
6	7,1	7	--	
6	7,1	8	RETURN After pushing RETURN, the second MATHEMATCS menu becomes visible.	

6 7,2 F.F.T.> OPTIONAL



If F.F.T. is selected, the MATHEMATCS F.F.T. menu becomes visible and the source and destination can be selected.
The result register will contain the frequency spectrum of the source CH.
When a window is selected, the source is multiplied by the WINDOW function, before the F.F.T. is performed. Windowing is used to reduce the effect of leakage at the edges of the source channel. (F.F.T. assumes the register to be exactly one period of a periodic signal, which normally is not the case.)
The F.F.T. is started and stopped with the START STOP softkey. Starting F.F.T. will stop any other active MATHEMATCS function.

6 7,2 1 CH :R. ...>



If CH :R. ... is selected, the CH menu becomes visible and the source channel can be selected from the registers. If there are two channels in a register, the selected trace is displayed intensified.

6 7,2 1 1 R0 ...

6 7,2 1 2 R1 ...

6 7,2 1 3 R2 ...

6 7,2 1 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH.
If there are two channels in the selected register then pressing the softkey again will result in switching between the two channels in the register.

6 7,2 1 5 --

6 7,2 1 6 --

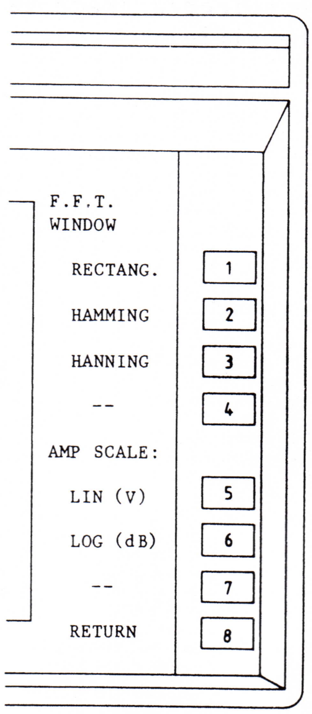
6 7,2 1 7 MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT:R.

6 7,2 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS F.F.T. menu becomes visible.

6 7,2 2 FFT PARAM.>



The FFT PARAM menu consists of 2 parts. In the top half the WINDOW is selected. The bottom part gives a selection for the amplitude scaling. The time scaling is always linear and depending on the time-base of the source register.
The source CH is multiplied by the WINDOW, which is used to reduce the effect of leakage.

6 7,2 2 1 RECTANG.

If RECTANG. is selected, the source channel is multiplied by a window with the value 1 over the selected part of the channel. So the real channel values are used for the FFT calculation.

6 7,2 2 2 HAMMING

If HAMMING is selected, the source CH is multiplied by the function:

$$f(t) = 0.08 + 0.46(1-\cos 2\ \ t/T)$$

In which T is the length of the source channel or the part limited by the cursors.

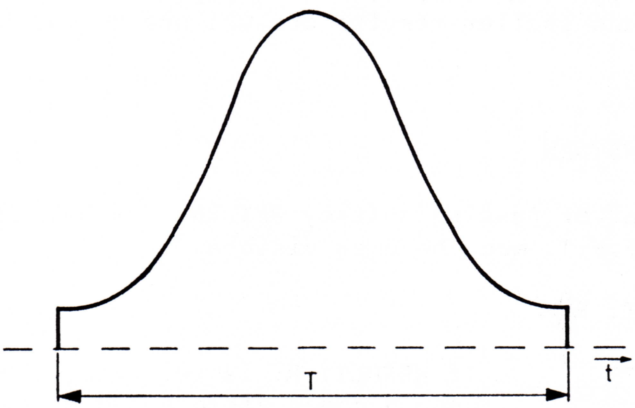


Figure 4.22 Hamming window.

6 7,2 2 3 HANNING

If HANNING is selected, the source CH is multiplied by the function:

$$f(t) = 0.5\ (1-\cos 2\ \ t/T)$$

In which T is the length of the source channel or the part limited by the cursors.

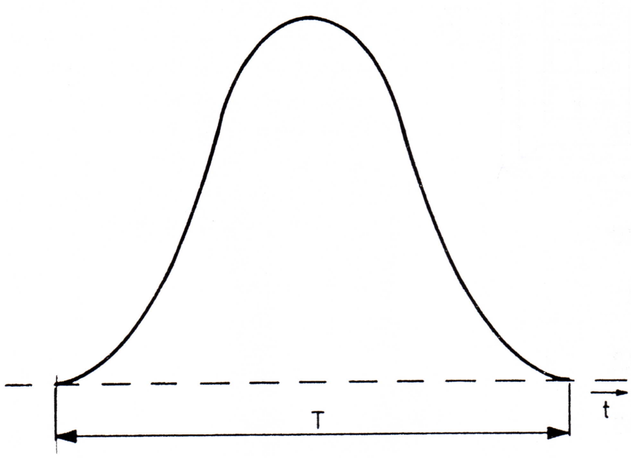


Figure 4.23 Hanning window.

6 7,2 2 4 --

6 7,2 2 5 LIN (V)

The result of the FFT is vertically displayed on a linear (voltage) scale.

6 7,2 2 6 LOG (dB)

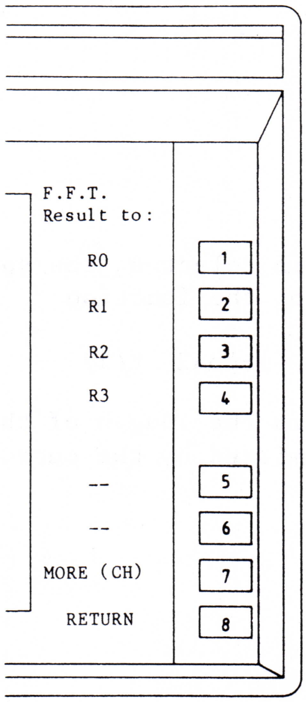
The result of the FFT is vertically displayed on a logarithm (dB) scale. The dynamic range is 49.8 dB and smaller results are all set to -49.8 dB.

6 7,2 2 7 --

6 7,2 2 8 RETURN

After pushing softkey RETURN, the MATHEMATCS F.F.T. menu becomes visible.

6 7,2 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6 7,2 3 1 R0

6 7,2 3 2 R1

6 7,2 3 3 R2

6 7,2 3 4 R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6 7,2 3 5 --

6 7,2 3 6 --

6 7,2 3 7 MORE (CH)

If MORE (CH) is pressed, the CH :R... menu will appear. MORE (CH) has the same result as pressing RETURN and than selecting CH :R...

6 7,2 3 8 RETURN

After pushing softkey RETURN, the MATHEMATCS F.F.T. menu becomes visible.

6 7,2 4 --

6 7,2 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function on or off. When the function is switched on, the MATHEMATCS F.F.T. function is performed on the channel between the cursors only. Channel points outside the cursors are put at 0 (zero filling).
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH.
When the function is active CURSOR LMT is displayed intensified.

6 7,2 6 START STOP

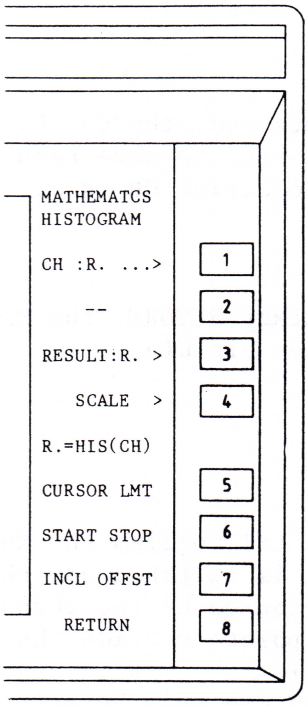
Pushing softkey START STOP starts or stops the MATHEMATCS F.F.T. operation. The actual state is displayed intensified.

6 7,2 7 INCL OFFST
Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the traces being included in the MATHEMATCS F.F.T. operation. When the function is active, INCL OFFST is displayed intensified.

6 7,2 8 RETURN

After pushing RETURN, the second MATHEMATCS menu becomes visible.

6 7,3 HYSTOGRAM>



If ADD is selected, the MATHEMATCS HYSTOGRAM menu becomes visible and the sources and destination can be selected.
Hystogram indicates the probability that a time varying signal will assume a value within a fixed amplitude range.

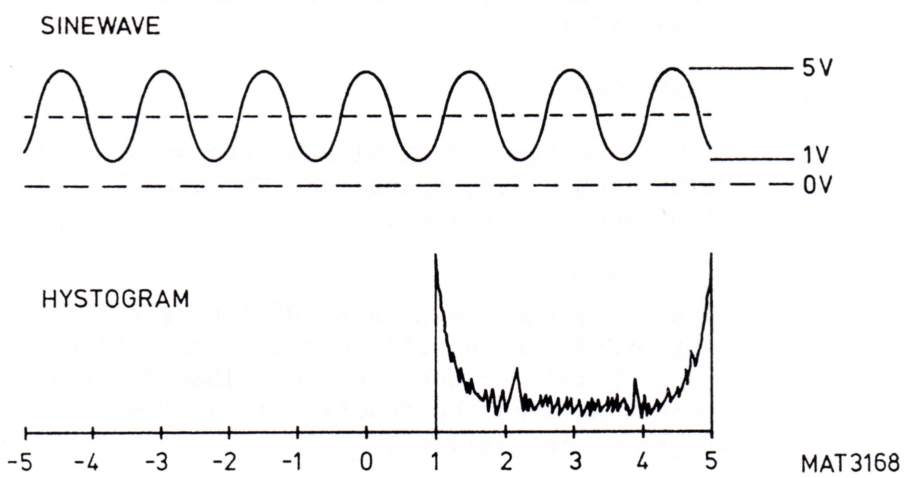
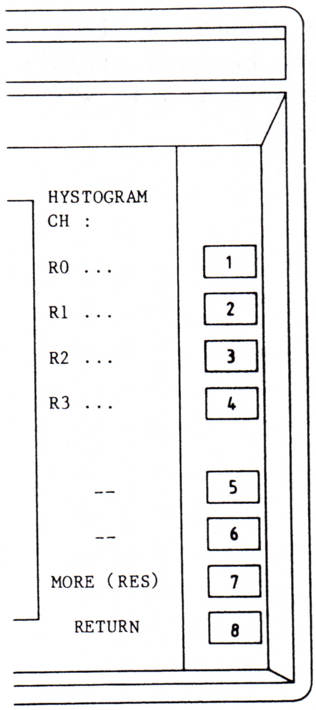


Figure 4.24 Hystogram display.

6 7,3 1 CH :R. ...>



If CH :R. ... is selected, the CH menu becomes visible and the source trace can be selected from the registers. If there are two traces in a register, the selected trace is displayed intensified.

6 7,3 1 1 R0 ...

6 7,3 1 2 R1 ...

6 7,3 1 3 R2 ...

6 7,3 1 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH.
If there are two channels in the selected register then pressing the softkey again will result in toggling between the two channels in the register.

6 7,3 1 5 --

6 7,3 1 6 --

6 7,3 1 7 MORE (RES)

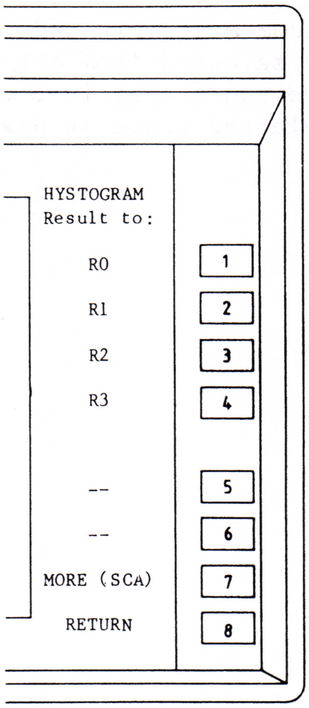
If MORE (RES) is pressed, the RESULT:R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT:R.

6 7,3 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS HYSTOGRAM menu becomes visible.

6 7,3 2 --

6 7,3 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6 7,3 3 1 R0

6 7,3 3 2 R1

6 7,3 3 3 R2

6 7,3 3 4 R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6 7,3 3 5 --

6 7,3 3 6 --

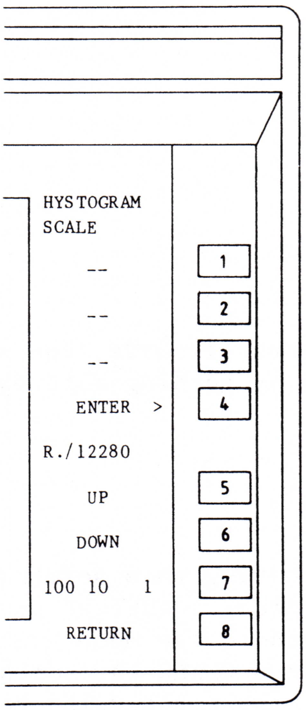
6 7,3 3 7 MORE (SCA)

If MORE (SCA) is pressed, the SCALE menu will appear. MORE (SCA) has the same result as pressing RETURN and selecting SCALE.

6 7,3 3 8 RETURN

After pushing softkey RETURN, the MATHEMATCS HYSTOGRAM menu becomes visible.

6 7,3 4 SCALE>



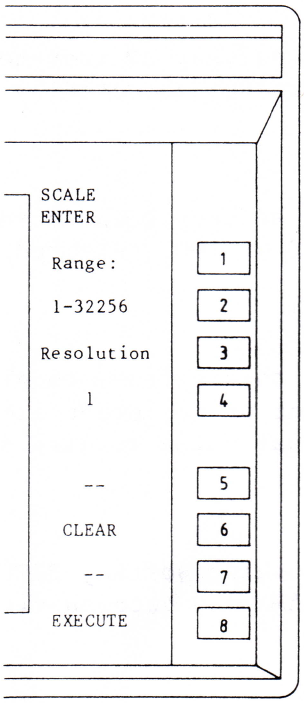
If SCALE is pressed, the SCALE menu becomes visible and a scaling factor can be selected to get the resulting trace of the MATHEMATCS HYSTOGRAM operation inside the vertical register range.

6 7,3 4 1 --

6 7,3 4 2 --

6 7,3 4 3 --

6 7,3 4 4 ENTER>



If ENTER is selected, the HYSTOGRAM SCALE menu will be displayed and the scale factor can be selected with the numeric keyboard. The actual range and the value are visible in the softkey text area.

A message

Too many digits: total entry is cleared.

is displayed if too many digits are entered via the numeric keyboard.

Or a message

No decimal point allowed in this enter menu.

is displayed if a decimal point is entered via the numeric keyboard.

6	7,3	4	4	1	--
6	7,3	4	4	2	--
6	7,3	4	4	3	--
6	7,3	4	4	4	--
6	7,3	4	4	5	--
6	7,3	4	4	6	CLEAR If an error is made, the scale value can be cleared by pushing softkey CLEAR.
6	7,3	4	4	7	--
6	7,3	4	4	8	EXECUTE After pushing this softkey, the selected scale value is entered and an AUTO RETURN is performed to the menu HYSTOGRAM SCALE. If after a CLEAR the softkey EXECUTE is pressed the scale value keeps its previous value in the HYSTOGRAM SCALE menu. A message HYSTOGRAM SCALE number out of range is displayed if the entered value exceeds the given range.
6	7,3	4	5	UP Pushing softkey UP increments the scale factor by 1, 10 or 100, selected by softkey 7.	
6	7,3	4	6	DOWN Pushing softkey DOWN decrements the scale factor by 1, 10 or 100, selected by softkey 7.	
6	7,3	4	7	100 10 1 Pushing this softkey toggles the size of the increment or decrement step between 100, 10 and 1. The actual value is displayed intensified.	
6	7,3	4	8	RETURN After pushing softkey RETURN, the MATHEMATCS HYSTOGRAM menu becomes visible.	

6 7,3 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function on or off. When the function is switched on, the MATHEMATCS HYSTOGRAM function is performed on the traces between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH.
When the function is active CURSOR LMT is displayed intensified.

6 7,3 6 START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS HYSTOGRAM operation. The actual state is displayed intensified.

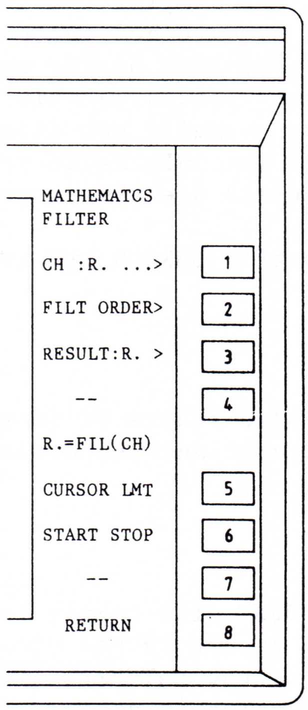
6 7,3 7 INCL OFFST

Pushing softkey INCL OFFST will toggle this function. INCL OFFST active will result in the offset of the traces being included in the MATHEMATCS HYSTOGRAM operation. When the function is active, INCL OFFST is displayed intensified.

6 7,3 8 RETURN

After pushing RETURN, the second MATHEMATCS menu becomes visible.

6 7,4 FILTER> OPTIONAL



If FILTER is selected, the MATHEMATCS FILTER menu becomes visible and the source and destination can be selected.
The FILTER function is smoothing the source register and storing the result in the result register.
The FILTER ORDER is the number of points that is used to calculate 1 resulting point. Each resulting point is the addition of the corresponding source point and its neighbours each multiplied by a factor according the filter formula.

$$\text{Filter}(n)=\frac{1-\cos(2\text{pi}\, n/(N+1))}{\sum_{k=1}^{N}(1-\cos(2\text{pi}\, k/(N+1)))}\quad\text{for } 1\le n\le N$$

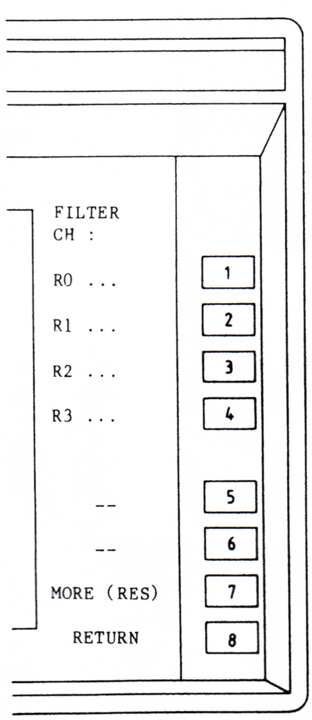
The sum of these filter factors is always 1.

e.g. When N=3 then Filter(1) = 0.250
Filter(2) = 0.500
Filter(3) = 0.250

The formula for the resulting points is:

$$\text{Result}(n)=\sum_{k=n-(N-1)/2}^{n+(N-1)/2}(\text{filter}(n-k+(N+1)/2)*\text{Source}(k))$$

6 7,4 1 CH :R. ...>



If CH :R. ... is selected, the CH menu becomes visible and the source channel can be selected from the registers.
If there are two channels in a register, the filter function will operate on both channels

6 7,4 1 1 R0 ...

6 7,4 1 2 R1 ...

6 7,4 1 3 R2 ...

6 7,4 1 4 R3 ...

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as source CH.
If two channels are present in the selected register, the filter operation will be performed on both channels.

6 7,4 1 5 --

6 7,4 1 6 --

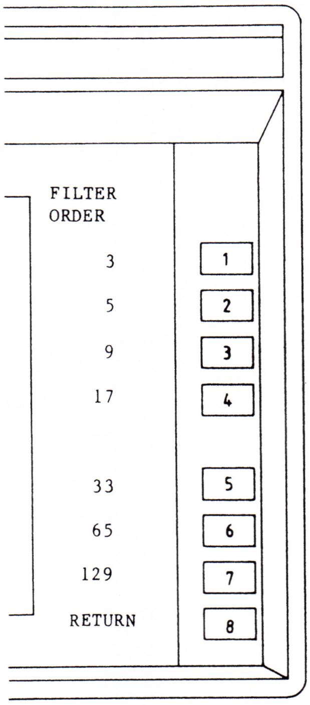
6 7,4 1 7 MORE (RES)

If MORE (RES) is pressed, the RESULT:R. menu will appear. MORE (RES) has the same result as pressing RETURN and selecting RESULT:R.

6 7,4 1 8 RETURN

After pushing softkey RETURN, the MATHEMATCS FILTER menu becomes visible.

6 7,4 2 FILT ORDER>



If FILT ORDER is selected, the FILTER ORDER menu becomes visible and the order can be selected.

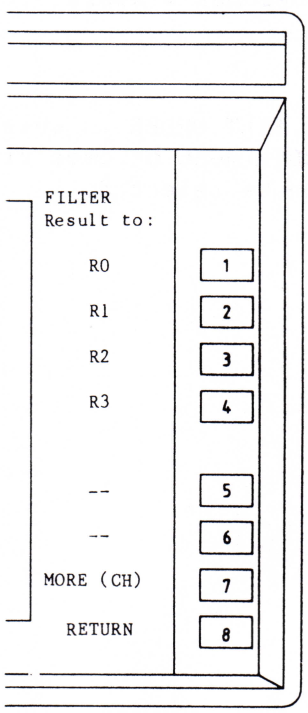
6	7,4	2	1	3
6	7,4	2	2	5
6	7,4	2	3	9
6	7,4	2	4	17
6	7,4	2	5	33
6	7,4	2	6	65
6	7,4	2	7	129

Pressing one of the softkeys 1 ... 7 will select the filter order.
Filter order is the number of points that is used to calculate 1 resulting point (see description at FILTER menu above).

6 7,4 2 8 RETURN

After pushing softkey RETURN, the MATHEMATCS FILTER menu becomes visible.

6 7,4 3 RESULT: R.>



If RESULT: R. is selected, the RESULT menu becomes visible and a register can be selected in which the result is stored.

6	7,4	3	1	R0
6	7,4	3	2	R1
6	7,4	3	3	R2
6	7,4	3	4	R3

If softkey 1, 2, 3 or 4 is pressed, register R0, R1, R2 or R3 is selected as result register.

6 7,4 3 5 --

6 7,4 3 6 --

6 7,4 3 7 MORE (CH)

If MORE (CH) is pressed, the CH :R. ... menu will appear. MORE (CH) has the same result as pressing RETURN and selecting CH :R. ...

6 7,4 3 8 RETURN

After pushing softkey RETURN, the MATHEMATCS FILTER menu becomes visible.

6 7,4 4 --

6 7,4 5 CURSOR LMT

Pushing softkey CURSOR LMT toggles the function on or off. When the function is switched on, the MATHEMATCS FILTER function is performed on the traces between the cursors only. Display points outside the cursors are put at -512 and are normally not displayed.
The function CURSOR LMT can only be selected when the cursors are ON. The cursors are then automatically positioned on CH.
When the function is active CURSOR LMT is displayed intensified.

6 7,4 6 START STOP

Pushing softkey START STOP starts or stops the MATHEMATCS FILTER operation. The actual state is displayed intensified.

6 7,4 7 --

6 7,4 8 RETURN

After pushing RETURN, the second MATHEMATCS menu becomes visible.

6 7,5 --

6 7,6 --

6 7,7 MORE

If MORE is pressed, the first MATHEMATCS menu will appear. MORE has the same result as pressing RETURN and then selecting MATHEMATCS.

6 7,8 RETURN

After pushing softkey RETURN, the CURSOR SELECT menu becomes visible.

7 RESTART

If the cursors are positioned on different traces or in the registers R1, R2 or R3, the text RESTART is not visible.

If the cursors are in one of the traces of register R0 the text RESTART is displayed.

After pushing softkey RESTART an automatic horizontal acquisition expand is performed for the signal part between the two cursors. A new trigger-delay setting (related to the first cursors) and a new and faster time-base setting (related to the time between the cursors) is automatically selected. After this selection a new signal is recorded with this new settings on the first active trigger.

The new settings are displayed in the top text area and the text RESTART is visible in high intensity.
The new settings are choosen in such a way, that the original signal part between the cursors, remains completely visible on the screen and is recorded with the maximum possible resolution.

If further expansion is not possible, this is indicated by one of the messages

No further expansion possible!!
RESTART not executed.

or

RESTART not fully executed because of
overflow in time base or trigger delay.

or

No more than 9 RESTART calculations possible.

Note: The first messages appears, if the distance between the cursors is so big, that even in one time-base setting faster, the original part between the cursors can't be displayed completely.
It also appears in the fastest time-base setting or if further expansion requires exceeding of the maximum trigger delay.

8 REVERSE

Normally the text REVERSE is not visible.
After the first operation of the RESTART function, the text REVERSE is visible.
If softkey REVERSE is pushed, then the settings as before performing the RESTART action are recalled.
REVERSE can stay visible, after the conditions for RESTART disappear or the cursors are switched OFF. This because the number of RESTART's is larger than the number of REVERSE's already given.

4.2.9 MEMORY SECTION AND MENU STRUCTURE

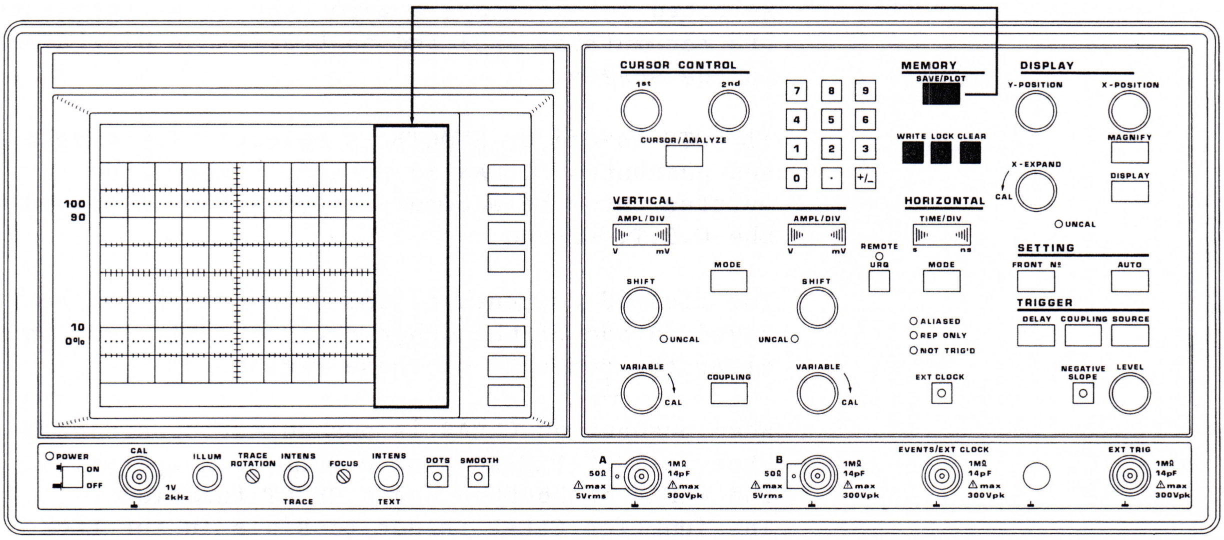
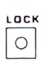


Figure 4.25 Front panel view.

The acquisition functions only when pushbutton WRITE is pushed.
The status is indicated by a pilot lamp in this switch.



If pushbutton LOCK is pushed, no signal acquisition (new input) is possible.
The status is indicated by a pilot lamp in this switch.

The following actions are still possible:

- -Plot actions.
- -Display actions.
- -Cursor control actions.
- -Setting of the acquisition system.
  Not possible are all acquisition actions which directly influence the contents of register R0.
- -Data can be saved in a register after a message has been given.
- -Front number actions (also RECALLs).

If pushbutton AUTO-SET is pushed when the instrument is in the LOCK-mode, the message

NO AUTO SET possible in LOCK mode.

is displayed in the bottom text area.

CLEAR

If pushbutton CLEAR is pushed and dots are selected for display, a zero line is written into the accumulator (R0) and no traces are displayed on the screen.

If DOTS is off or SMOOTH is selected for display and pushbutton CLEAR is pushed, a zero line is written into the accumulator (R0) and displayed on the C.R.T. screen.

The cleared contents of the accumulator can be saved in one of the other registers R1...R3, to clear the contents of these registers.

When pushbutton CLEAR is pushed during a SINGLE-shot, a MULTIPLE-shot or a ROLL-mode operation, the CLEAR pushbutton has a RESET function.
The function CLEAR is not possible in the LOCK mode.

SAVE/PLOT

If pushbutton SAVE/PLOT is pushed, the SAVE/PLOT menu is displayed. See 4.2.9.1.

4.2.9.1 SAVE/PLOT MENU STRUCTURE

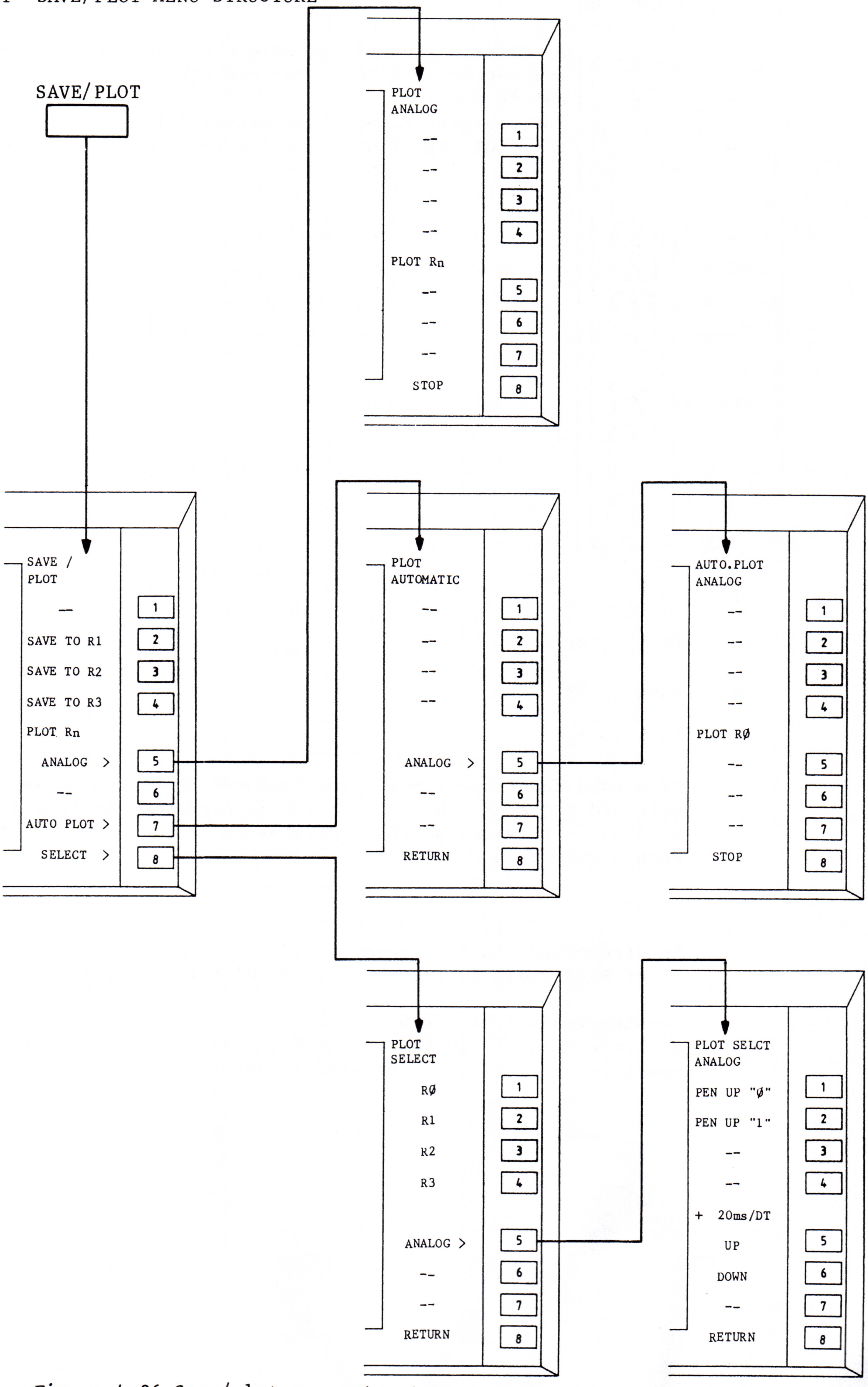
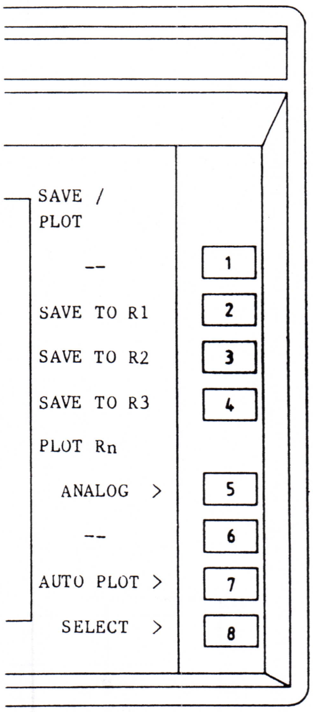


Figure 4.26 Save/plot menu structure.

SAVE/PLOT MENU



After selection of the SAVE/PLOT menu by depressing pushbutton SAVE/PLOT, various SAVE and PLOT selections can be done.
The register Rn which is selected for PLOT actions via the PLOT SELECT menu, is displayed on the screen.

1 --

2 SAVE TO R1

3 SAVE TO R2

4 SAVE TO R3

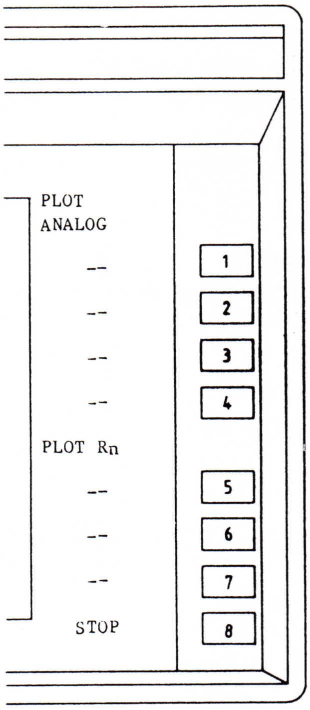
If a SAVE function is selected, register R0 is copied in the selected register. The SAVE action is performed as long as the softkey is pressed, so that register R0 is copied again after each acquisition.

A message

No direct SAVE in LOCK mode.
Press SAVE again during the display of this message.

becomes visible in the bottom text area for a short moment when the instrument is in the LOCK-mode. A SAVE action is then only possible as long as the message is displayed.

5 ANALOG>



If ANALOG is selected, the contents of the displayed register Rn is transferred to the analog plot output. The default register is R0.
Other registers to plot as well as the plot speed can be selected via the SELECT function of the SAVE/PLOT menu (softkey 8). During the PLOT action, the PLOT ANALOG menu is displayed and a dot, which moves from the left to the right (over 10 divisions) is displayed in the bottom text area of the screen to show the progress of the plot action and a message

* * * * * * * * PLOTTER ACTIVE * * * * * * * *
Changes are possible after plotter has stopped

is displayed.

At the end of the PLOT action, the menu SAVE/PLOT is displayed again.

5 1 --

5 2 --

5 3 --

5 4 --

5 5 --

5 6 --

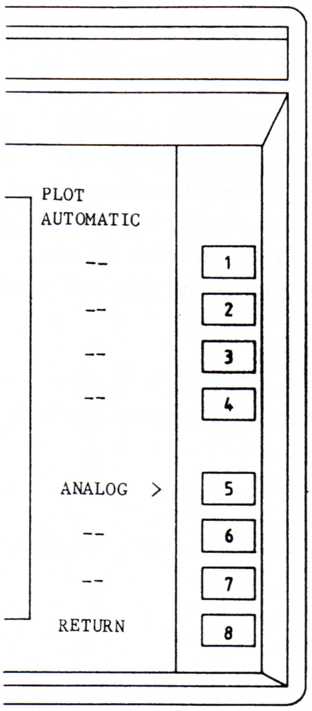
5 7 --

5 8 STOP

A PLOT action can be interrupted by pushing softkey STOP. The SAVE/PLOT menu is then displayed again. During a plot action, it is not possible to switch to another softkey menu.

6 --

7 AUTOPLOT>



AUTOPLOT functions only in the SINGLE-shot mode.
If AUTOPLOT is selected, the contents of register R0 is automatically transferred to an analog X-Y recorder.
The text AUTOPLOT in not visible in an other horizontal mode.

The contents of R0 is automatically plotted after each refreshment of the memory when a valid trigger is received.

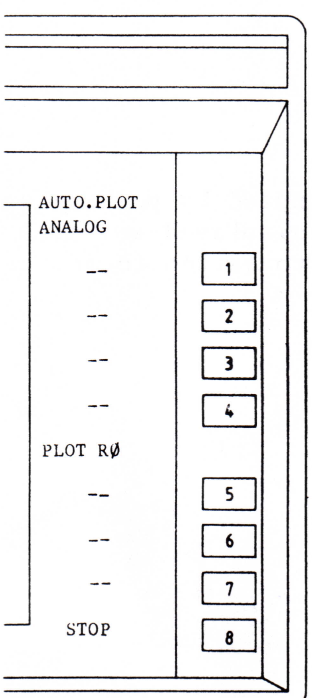
7 1 --

7 2 --

7 3 --

7 4 --

7 5 ANALOG>



After selecting ANALOG, the AUTOPLOT ANALOG menu is displayed and the function is active for an analog X-Y recorder.
The PLOT speed can be selected via the SELECT function of the SAVE/PLOT menu (softkey 8). During the PLOT action, the AUTO.PLOT ANALOG menu is displayed and a dot, which moves from the left to the right is displayed just above the bottom text area of the screen and a message

* * * * * * * * PLOTTER ACTIVE * * * * * * * *
Changes are possible after plotter has stopped

is displayed.

At the end of the PLOT action, a new acquisition takes place on receipt of a trigger signal, after which a new plot is initiated.

7 5 1 --

7 5 2 --

7 5 3 --

7 5 4 --

7 5 5 --

7 5 6 --

7 5 7 --

7 5 8 STOP

A PLOT action can be interrupted by pushing softkey STOP. The PLOT AUTOMATIC menu is then displayed again. During a plot action it is not possible to switch to an other softkey menu.

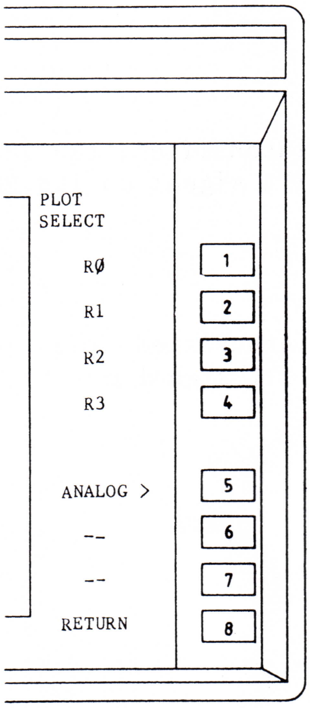
7 6 --

7 7 --

7 8 RETURN

After pushing softkey RETURN, the SAVE/PLOT menu is displayed again. The selections as made before remain unchanged.

8 SELECT>



If SELECT is selected, a selection can be made for a register, a plot output speed and the penlift output polarity.

Only the registers which are selected for display, can be selected for plot actions.

8 1 R0

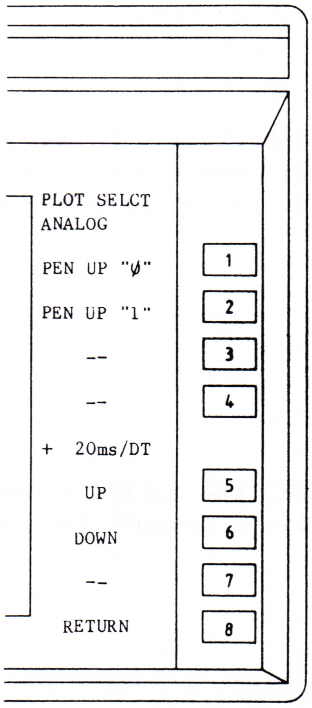
8 2 R1

8 3 R2

8 4 R3

Hard copies are made from the selected register.

8 5 ANALOG>



If ANALOG is selected, the PLOT SELECT ANALOG menu is displayed and the plot output speed as well as the penlift polarity can be selected.

8 5 1 PEN UP "0"

If the text PEN UP "0" is intensified, the instrument will generate a low level TTL signal on its PENLIFT output.

8 5 2 PEN UP "1"

If the text PEN UP "1" is intensified, the instrument will generate a high level TTL signal on its PENLIFT output.

8 5 3 --

8 5 4 --

8 5 5 UP

The actual analog plot output speed is displayed on the screen. This speed is always a multiple of 20 ms/dot. Pushing softkey UP increases the value in steps of 20 ms, which means that the actual plot output speed decreases. Above 200 ms/dot the value increases in steps of 100 ms/dot. The fastest possible output speed is 20 ms/dot.
If 2000 ms/DT is displayed, and UP is depressed, a message

PLOT TIME out of range. Range is 20 .. 2000 ms.

is displayed.

The real plot time may be different than selected, due to automatic plot control speed adaption related to the signal shape.

NOTE: This plot speed must be adapted to the speed of a relative slow X-Y recorder.

8 5 6 DOWN

The actual analog plot output speed is displayed on the screen. This speed is always a multiple of 20 ms/dot. Pushing softkey DOWN decreases the value in steps of 20 ms, which means that the actual plot output speed decreases. Above 200 ms/dot the value increases in steps of 100 ms/dot.
The slowest possible plot output speed is 2000 ms/dot.
If 20 ms/DT is displayed and DOWN is depressed, a message

PLOT TIME out of range. Range is 20 .. 2000 ms.

is displayed.
The real plot time may be different than selected, due to automatic plot control speed adaption related to the signal shape.

8 5 7 --

8 5 8 RETURN

After pushing softkey RETURN, the PLOT SELECT menu is displayed again. The selections as made before remain unchanged.

8 6 --

8 7 --

8 8 RETURN

After pushing softkey RETURN, the SAVE/PLOT menu is displayed again.

4.2.10. DISPLAY SECTION AND MENU STRUCTURE

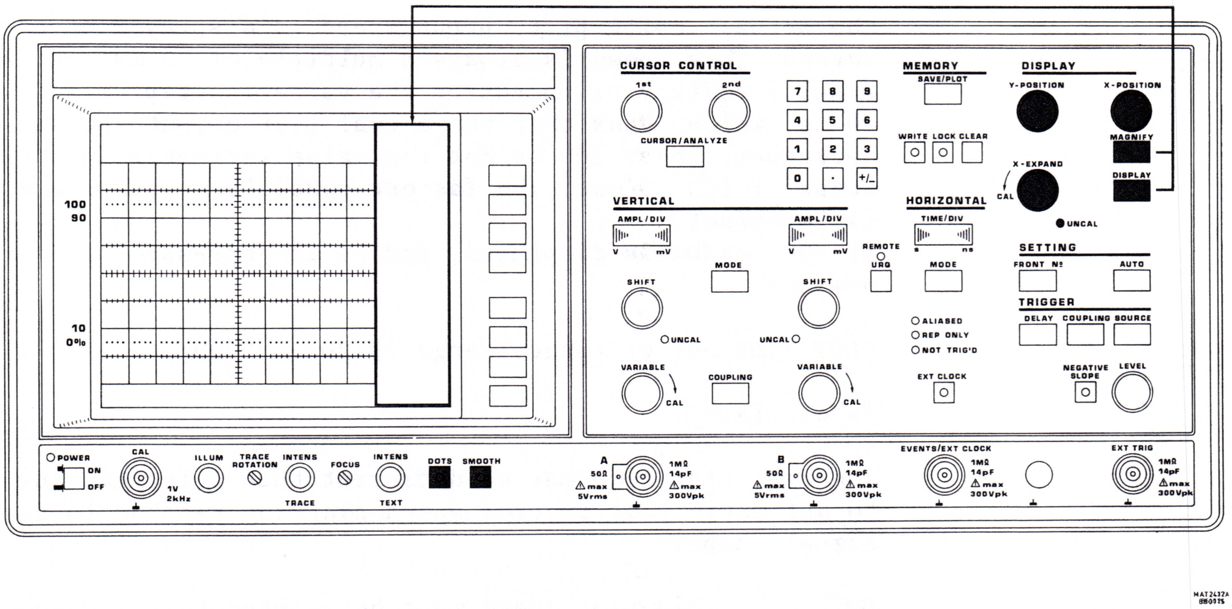
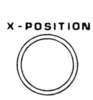


Figure 4.27 Front panel view.

Continuously variable control giving vertical shift of one of the four registers R0, R1, R2, R3 (including channels in the registers) can be addressed via the DISPLAY menu.

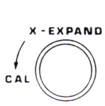
The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.



Continuously variable control giving horizontal shift of the total trace display.

Can also be addressed to one of the four registers R0, R1, R2, R3 (including channels in the registers) as long as menu DISPLAY Rn POSITION is selected.

The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.



Continuously variable control for horizontal expand of the total trace display.

Can also be addressed to one of the four registers R0, R1, R2, R3 (including channels in the registers) as long as menu DISPLAY Rn POSITION is selected.

The adjusting speed increases after turning continuously in one direction. After stopping, starting in the reverse direction resumes with a slow adjusting speed.

UNCAL

Pilot lamp indicating that the X-EXPAND function is active for one or more registers. If the X-EXPAND control is fully turned anti clockwise, the UNCAL pilot lamp is switched off.

DOTS

Selection between a display of discrete dots or a display of joined dots for all registers. DOTS can also be selected in A VERSUS B mode.

SMOOTH

Selection between normal and smoothed display by switching a smoothing RC-filter in the display channel for all registers.
The dots will disappear. SMOOTH can also be selected in A VERSUS B mode.

Note: SMOOTH can effect the signal on the screen, because of the decrease in bandwidth of the display channel.

MAGNIFY

If pushbutton MAGNIFY is pushed, the MAGNIFY menu is displayed. See 4.2.10.1.

DISPLAY

If pushbutton DISPLAY is pushed, the DISPLAY menu is displayed. See 4.2.10.2.

4.2.10.1 MAGNIFY MENU STRUCTURE

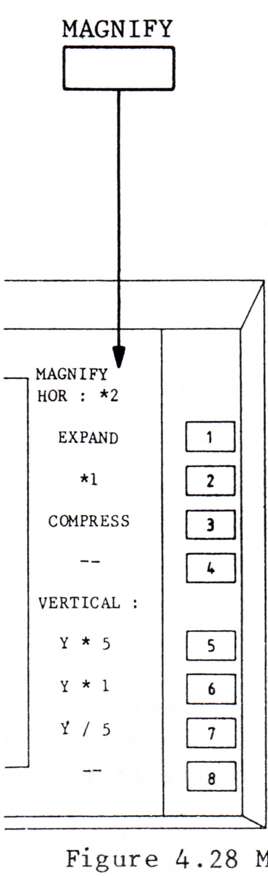
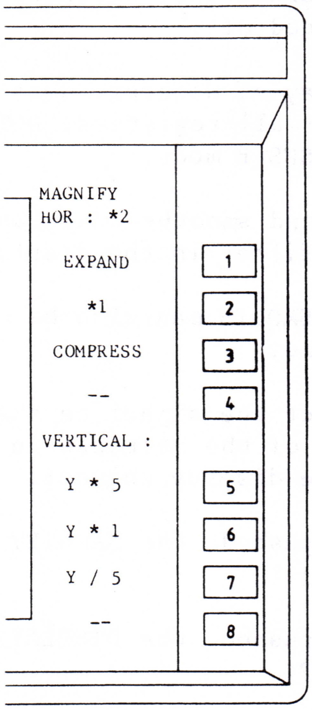


Figure 4.28 Magnify menu structure.

MAGNIFY MENU



After selection of the MAGNIFY menu by depressing pushbutton MAGNIFY, the signal(s) can be expanded in horizontal or vertical direction.

*1, *2, *4, *8, *16 *32 or *64 horizontal expand can be selected.

Each part of the complete register can be displayed using the HORIZONTAL POSITION control.

1 EXPAND

With softkey EXPAND, higher horizontal expand factors can be selected until *64 is reached. Then the text expand is not displayed any longer. EXPAND is always with respect to mid-screen.
The selected factor is displayed in the second line of the softkey menu header.
With A VS B selected, the maximum expand factor is *8.

2 *1

With softkey *1, the horizontal expand factor is set to *1 which means -no expand-.

3 COMPRESS

With softkey COMPRESS, lower horizontal expand factors can be selected until *1 is reached. The selected factor is displayed in the second line of the softkey menu header.
The text COMPRESS is not visible if the expand factor is *1.

4 --

5 Y*5

After pushing softkey Y*5, the vertical expand factor is set to *5 and 1/5 of the contents of the selected registers is displayed over 10 vertical divisions of which 8 divisions are visible. Mid-memory is displayed on the center-line of the graticule.

6 Y*1

After pushing softkey Y*1, the vertical expand factor is set to *1 and the contents of the selected registers is displayed over 10 vertical divisions of which 8 divisions are visible. Mid-memory is displayed on the center-line of the graticule.

7 Y/5

After pushing softkey Y/5, the contents of each memory is displayed over 2 vertical divisions. If the Y-positions are in zero position, the registers are equally divided over the screen.

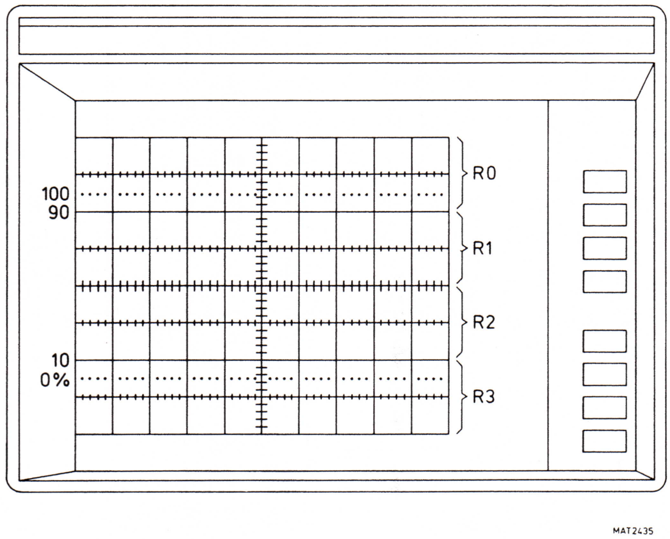


Figure 4.29 Y/5 display.

8 --

4.2.10.2 DISPLAY MENU STRUCTURE

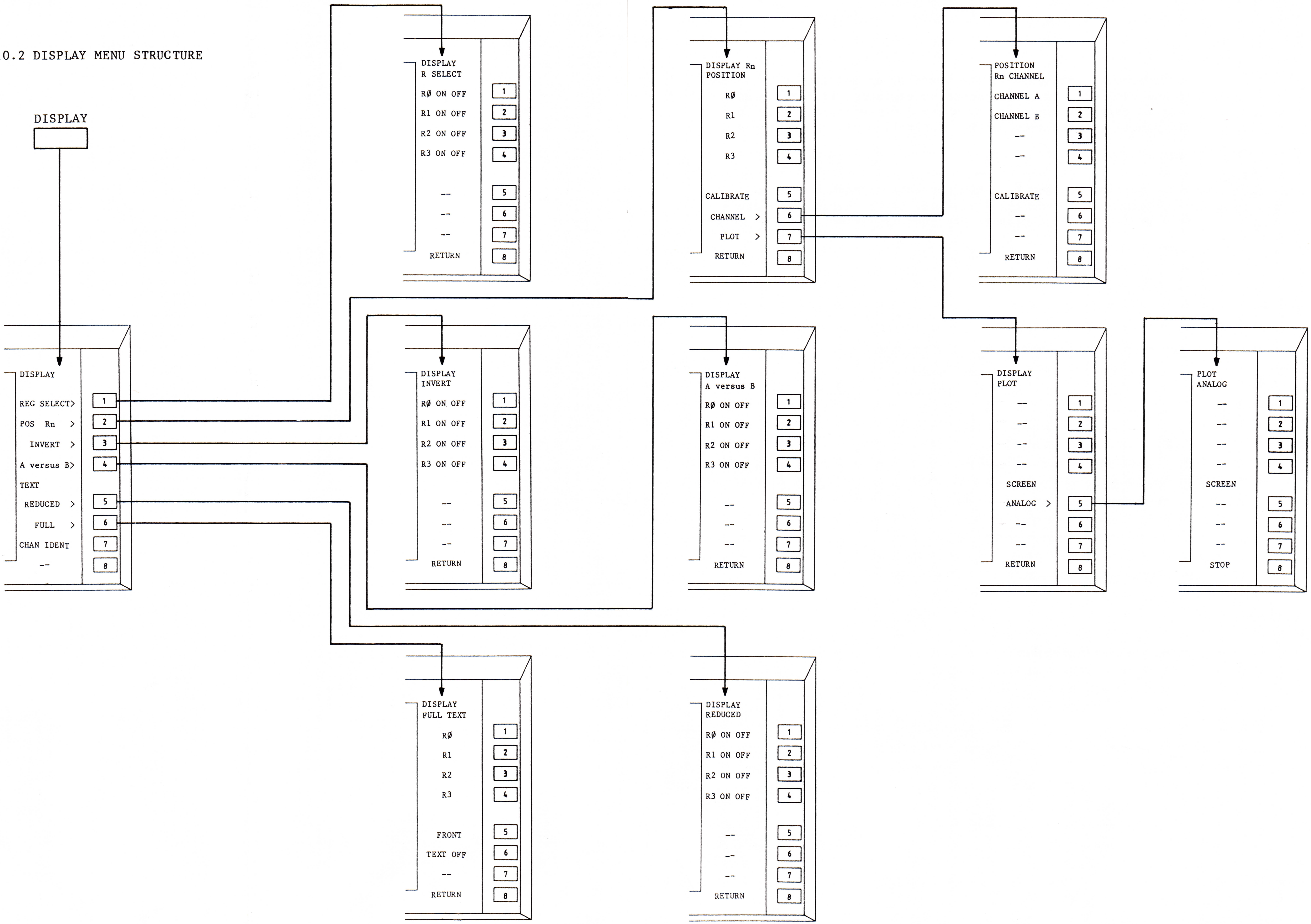
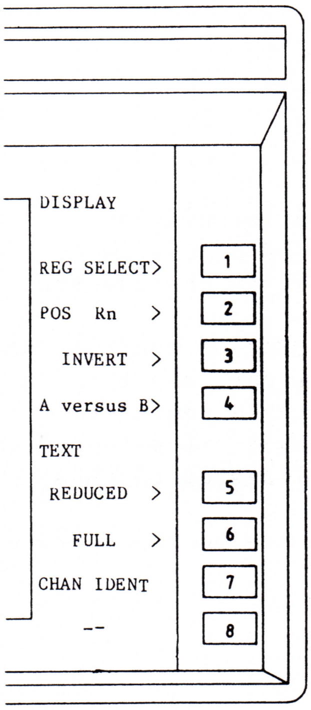


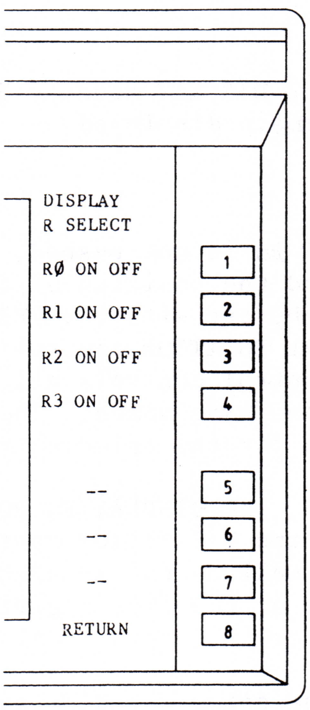
Figure 4.30 Display menu structure.

DISPLAY MENU



After selection of the DISPLAY menu by depressing pushbutton DISPLAY, various DISPLAY selections can be made.

1 REG SELECT>



After selecting REG SELECT, the DISPLAY/R SELECT menu is displayed and a selection can be made of the registers which have to be displayed.

1 1 RO ON OFF

1 2 R1 ON OFF

1 3 R2 ON OFF

1 4 R3 ON OFF

One or more registers can be selected for display. Depending on the selection, the text ON or OFF is intensified. Pushing the relevant softkey changes the situation from ON to OFF or reverse.
If a register is switched OFF, the POSITION controls which are eventually addressed to this register, are from that moment on addressed to the next displayed register.
If a register which is not yet displayed, is selected for display, the POSITION controls are addressed to this register.
If cursors are selected, the cursors are on the selected register now.

1 5 --

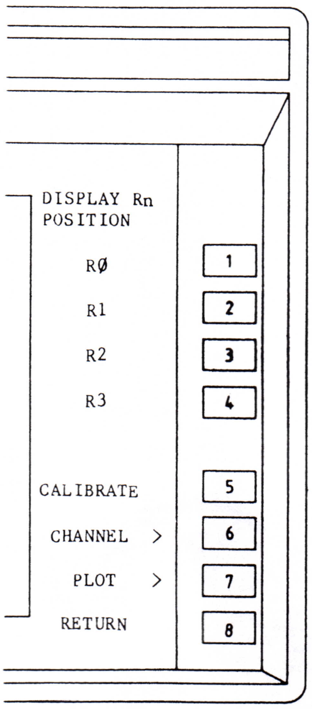
1 6 --

1 7 --

1 8 RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed again. The selected registers remain displayed.

2 POS Rn>



As long as softkey POS Rn is not pushed, the text POS Rn is displayed and the position of the selected register can be set with the VERTICAL POSITION and HORIZONTAL POSITION control. The HORIZONTAL POSITION control controls all other registers as well at the same moment. The X-EXPAND control functions also for the selected register.

After selecting POS Rn, the DISPLAY Rn POSITION menu is displayed and the Y-POSITION control, the X-POSITION control as well as the X-EXPAND control can be assigned to one of the four registers. The selected register number is intensified.

If a register is not selected for display, this register can not be selected for positioning. The text Rn for this register is then not displayed.

2 1 R0

2 2 R1

2 3 R2

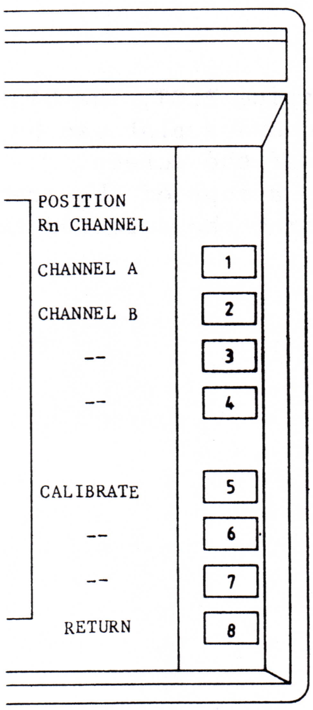
2 4 R3

The Y-POSITION, X-POSITION and X-EXPAND controls are addressed to the selected register.

2 5 CALIBRATE

After pushing softkey CALIBRATE, the traces are set as before pushing softkey CHANNEL (see next description).
The Y-POSITION is set so, that mid-memory is mid-screen in Y*1 and Y*5 mode and on +3, +1, -1 and/or -3 divisions in the Y/5 mode.
The X-POSITION is set so, that the beginning of the trace is situated on the most left graticule line.
The X-EXPAND is set to its calibrated position.

2 6 CHANNEL>



If CHANNEL is selected, the POSITION Rn CHANNEL menu is displayed.
Traces within the same register can now be positioned in relation to each other.
If only one channel is recorded in the selected register, this menu can not be reached and the text CHANNEL is not visible.

2 6 1 CHANNEL A

2 6 2 CHANNEL B

The position of the selected channel A or B in the selected register Rn can be changed with the Y-POSITION, the X-POSITION and the X-EXPAND controls.

2 6 3 --

2 6 4 --

2 6 5 CALIBRATE

After pushing softkey CALIBRATE, the display modifications made under channel control are ignored and the traces are adjusted as follows.
The Y-POSITION is set so, that mid-memory is mid-screen in Y*1 and Y*5 mode and on +3, +1, -1, and/or -3 divisions in the Y/5 mode.
The X-POSITION is set so, that the beginning of the trace is situated on the most left graticule line.
The X-EXPAND is set to its calibrated position.
The controls are not longer addressed to one of the channels A or B but to the selected register.

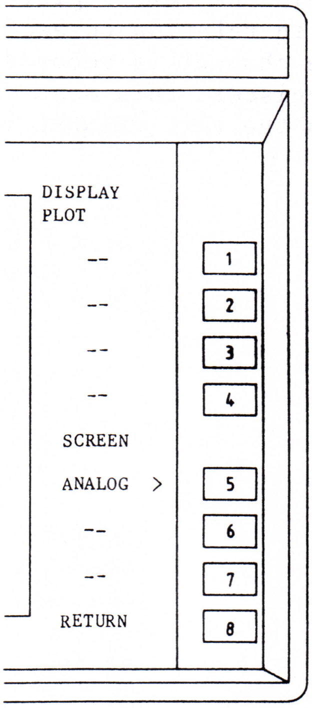
2 6 6 --

2 6 7 --

2 6 8 RETURN

After pushing softkey RETURN, the DISPLAY Rn POSITION menu is displayed again.
All settings done before remain unchanged.

2 7 PLOT>



After selecting PLOT, the DISPLAY PLOT menu is selected and a plot can be made from the trace area of the screen.
In this way a copy of the trace area can be made including the selected trace position changes.

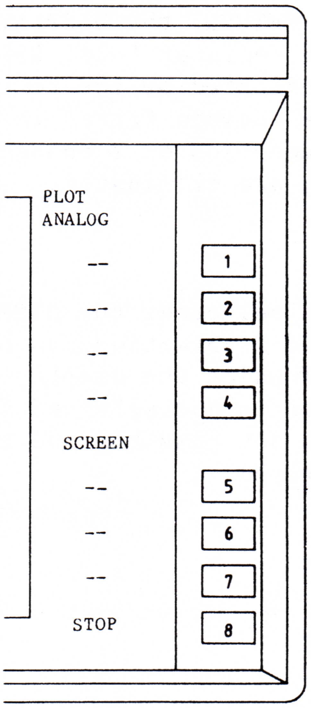
2 7 1 --

2 7 2 --

2 7 3 --

2 7 4 --

2 7 5 ANALOG>



After selecting ANALOG, a copy of the screen is made on an analog X-Y recorder. During the PLOT action, the PLOT ANALOG menu is displayed and a dot which moves from the left to the right (over 10 divisions) is displayed in the bottom text area of the screen to show the progress of the plot action and a message

* * * * * * * * PLOTTER ACTIVE * * * * * * * *
Changes are possible after plotter has stopped.

is displayed.

The settings made with the Y-POSITION control, the X-POSITION control and the X-EXPAND control remain.
At the end of the plot action the menu DISPLAY PLOT is displayed again.

2 7 5 1 --

2 7 5 2 --

2 7 5 3 --

2 7 5 4 --

2 7 5 5 --

2 7 5 6 --

2 7 5 7 --

2 7 5 8 STOP

A PLOT action can be interrupted by pushing softkey STOP. The DISPLAY PLOT menu is then displayed again.

2 7 6 --

2 7 7 --

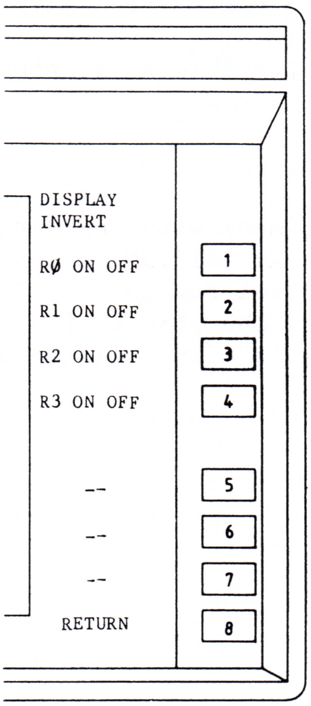
2 7 8 RETURN

After pushing softkey RETURN, the DISPLAY Rn POSITON menu is displayed again.

2 8 RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed again and the selected register (e.g. R2) can still be positioned. This is indicated by the text POS R2.
All modifications made between traces in X- as well as Y-direction (with the exception of Y changes, which are made via the CHANNEL menu), are eliminated.

3 INVERT>



If INVERT is selected, the DISPLAY/INVERT menu is displayed and a selection can be made of the registers of which the display has to be inverted. If a register is not selected for display, the inversion is not possible and the register number is not displayed.

3 1 RO ON OFF

3 2 R1 ON OFF

3 3 R2 ON OFF

3 4 R3 ON OFF

One or more registers can be selected for inverted display. Depending on the selection, the text ON or OFF is intensified.
Pushing the relevant softkey changes the situation from ON to OFF or reverse.

3 5 --

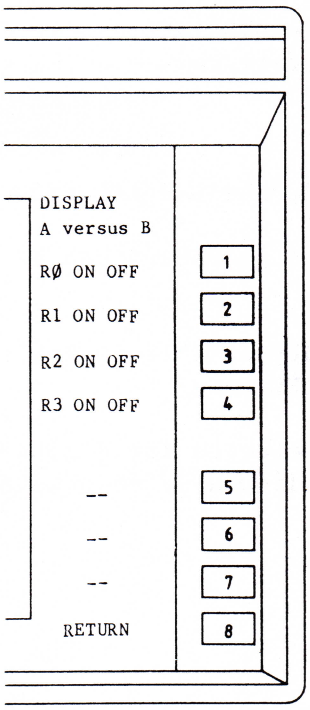
3 6 --

3 7 --

3 8 RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed again. The selections as made before remain unchanged.

4 A versus B>



If A versus B is selected, the DISPLAY A versus B menu is displayed.
One or more registers can be selected for A versus B display.
If a register is not selected for display, or if only one channel is recorded in a register, the text Rn ON OFF is not displayed and A versus B display is then not possible for this register.
If no register is displayed with two channels, A versus B is not possible and the text A versus B is not displayed and the function can not be selected.

NOTE: If a register is deselected via the DISPLAY/R SELECT menu, then A versus B is switched off for that register.

4 1 R0 ON OFF

4 2 R1 ON OFF

4 3 R2 ON OFF

4 4 R3 ON OFF

One or more registers can be selected for A versus B display.
Depending on the selection the text ON or OFF is intensified.
Pushing the relevant softkey changes the situation from ON to OFF or reverse.
If the CURSORS were selected for the selected register, a message

Register in A versus B : no cursors possible.

is displayed and the cursors are switched off.

If a horizontal expand greater than *8 is selected via the MAGNIFY menu, a message

Max. horizontal expand in A versus B is *8

is displayed and horizontal expand is set to *8.

4 5 --

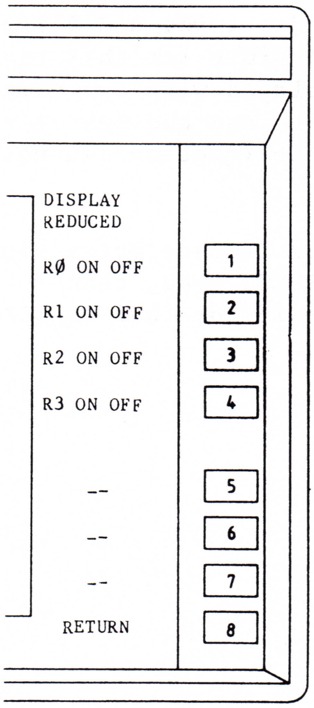
4 6 --

4 7 --

4 8 RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed again. The selections as made before remain unchanged.

5 REDUCED>



If REDUCED is selected, the DISPLAY REDUCED menu is displayed.
Only in Y/5 one or more registers can be selected for REDUCED text.

The text REDUCED is only visible if Y/5 is selected via the MAGNIFY menu.

If a register is not selected for display, the text Rn ON OFF is not displayed and the action is not possible.

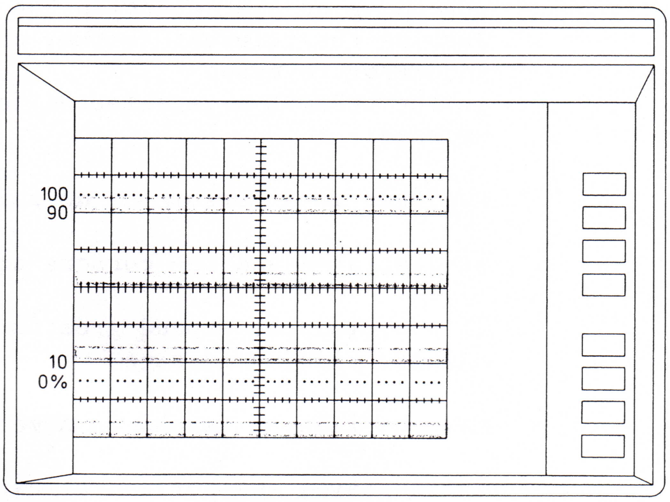


Figure 4.31 Reduced text display in Y/5.

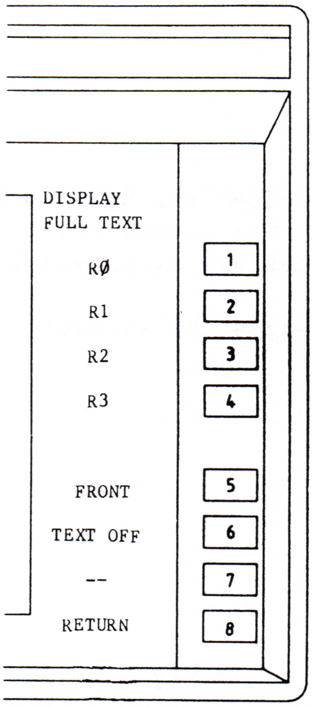
5	1	R0	ON	OFF
5	2	R1	ON	OFF
5	3	R2	ON	OFF
5	4	R3	ON	OFF

One or more registers can be selected for REDUCED TEXT display. Reduced text means that the parameters of the signal(s) of the selected register are displayed in the trace area. See also 4.2.2.
Pushing the relevant softkey changes the situation from ON to OFF or reverse.

5	5	--
5	6	--
5	7	--
5	8	RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed again. The selections as made before remain unchanged.

6 FULL>



If FULL is selected, the DISPLAY/FULL TEXT menu is displayed.

The most important information of the front panel settings is always visible in the top text area but selection of the display of full information of a certain register or the additional information of the front panel setting, is possible.

If a register is not selected for display, the text Rn is not displayed and the action is not possible for this register.

If a register which is selected for full text is turned off via the REGISTER SELECT menu, full text is turned off.

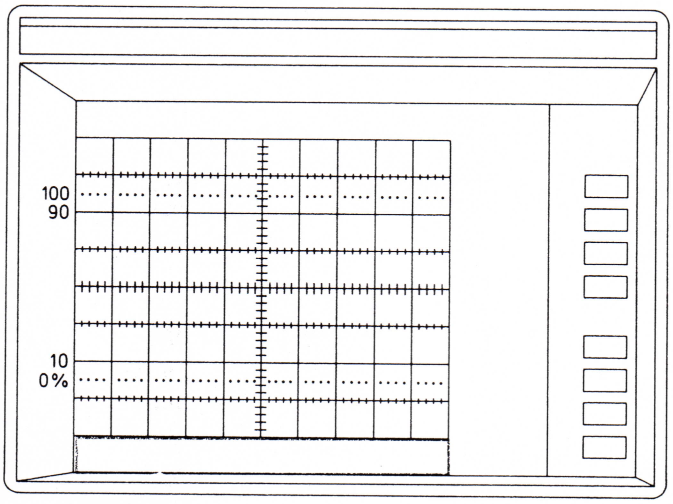


Figure 4.32 Full text display.

6 1 R0

6 2 R1

6 3 R2

6 4 R3

The parameters of the selected register can be selected for display in the bottom text area.
Front information in the bottom text area, selected by softkey FRONT is not longer displayed then.
Pushing the relevant softkey changes the situation from ON to OFF or reverse.

6 5 FRONT

With softkey FRONT, two extra lines with front panel information are visible in the bottom text area.
Register information in the bottom text area, selected by one of the softkeys R0, R1, R2 or R3 is not longer displayed then.

6 6 --

6 7 TEXT OFF

This text is only visible if full text is selected.
The bottom text area is blanked when softkey TEXT OFF is pushed.

6 8 RETURN

After pushing softkey RETURN, the DISPLAY menu is displayed again. The selections as made before remain unchanged.

7 CHAN IDENT

After pushing softkey CHAN IDENT, the channel identification (A and/or B) on the C.R.T. screen can be switched on or off.
Pushing this softkey changes the situation from ON to OFF or reverse, indicated by a high or a low intensity of the text CHAN IDENT.

8 --

4.2.11. FRONT No. SECTION AND MENU STRUCTURE

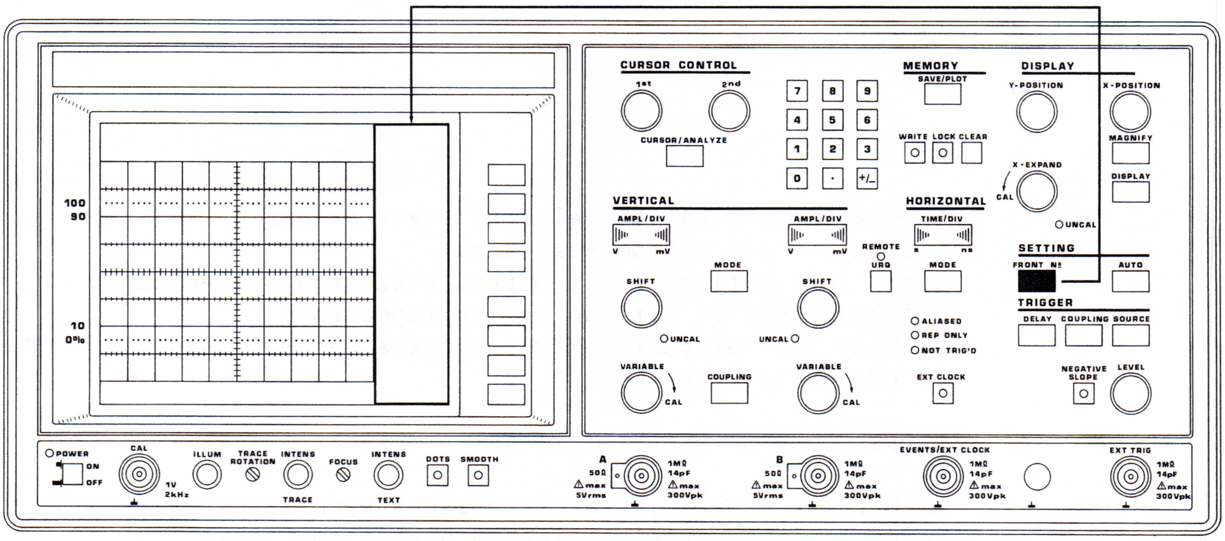
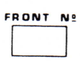


Figure 4.33 Front panel view.



If pushbutton FRONT No. is pushed, the FRONT NUMBER menu is displayed. See 4.3.11.1.

4.2.11.1 FRONT NUMBER MENU STRUCTURE

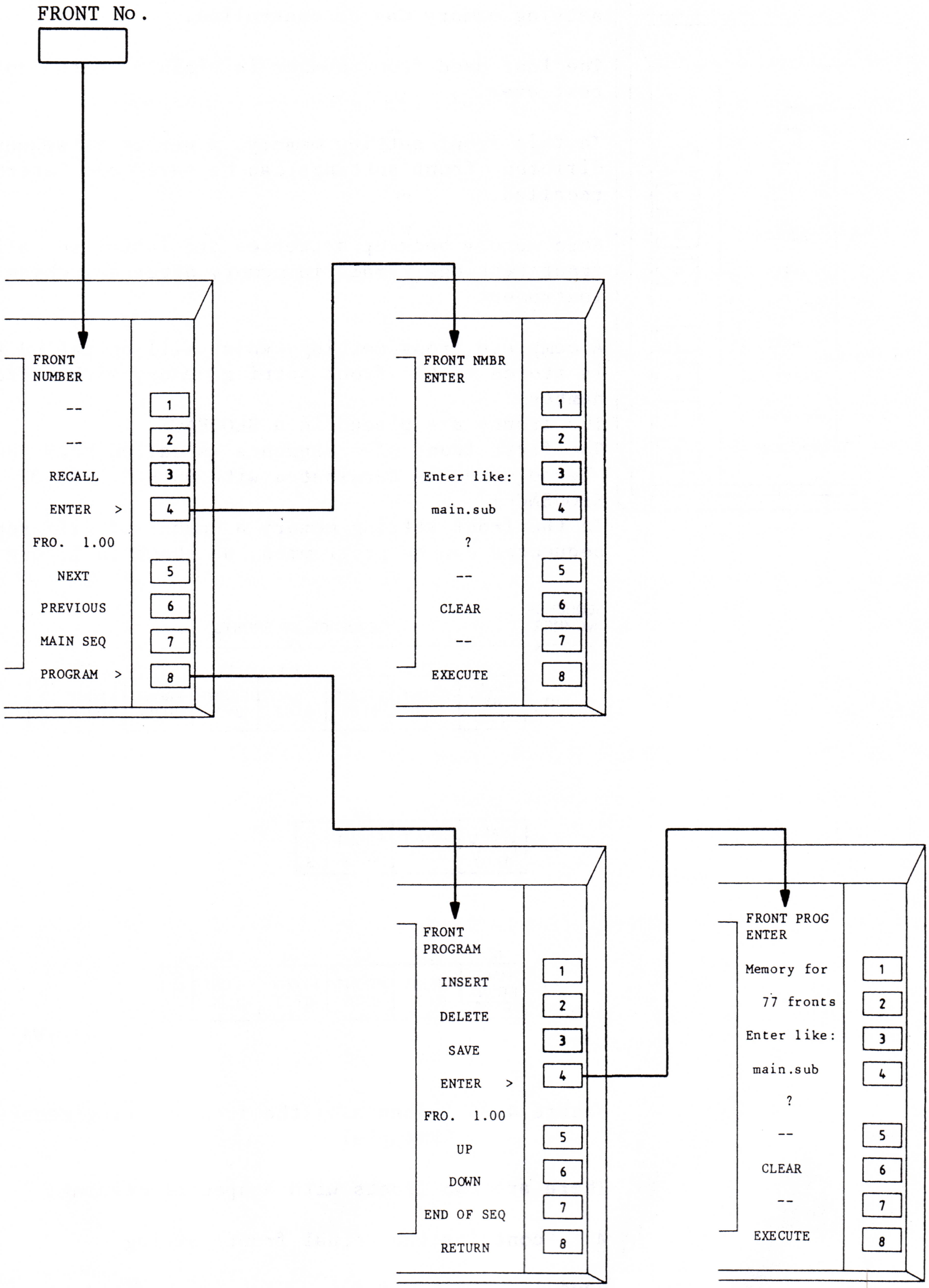
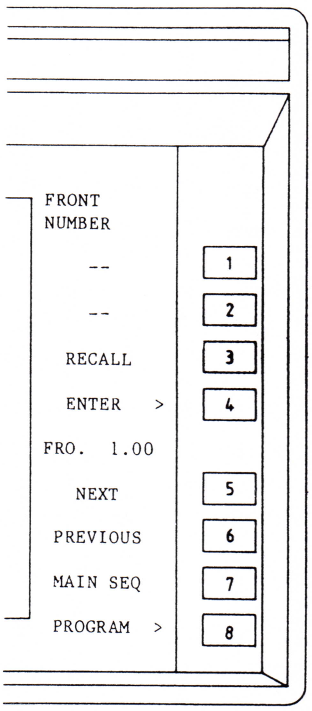


Figure 4.34 Front number menu structure.

FRONT NUMBER



If pushbutton FRONT No. is depressed, the FRONT NUMBER menu will be visible on the screen and the front setting memory can be controlled.

The last used front number is visible in the softkey text area.

In this front setting memory, a number of sequences of different front settings can be saved and later on recalled.

When memory back-up batteries are installed, all saved front settings remain in memory after switching off the instrument.

A complete front setting, which will be called FRONT, is stored in the front setting memory with a front number.
The fronts are placed in a SEQUENCE.
The first front of a sequence is called MAIN FRONT.
The sequence is terminated with an EOS (END OF SEQUENCE).
In the front setting memory a number of different sequences can be programmed, as shown in figure 4.35.

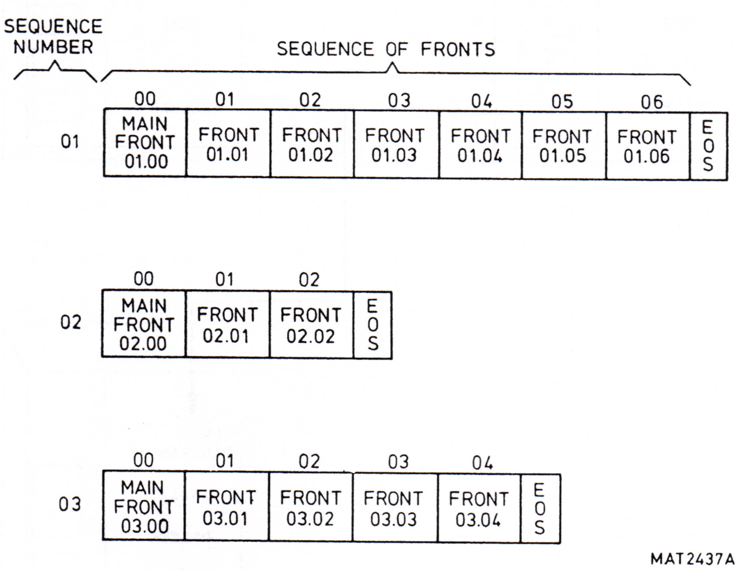


Figure 4.35 Contents of the front setting memory (Example)

There are two fronts with a special meaning:

Ø contains the actual front setting

9999 is a backup front, which can be used to restore a front that is deleted or overwritten by mistake.

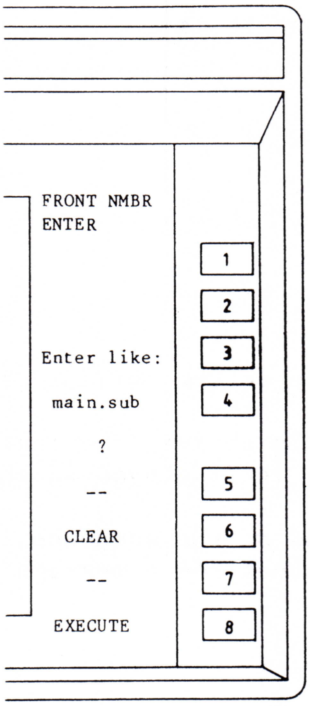
1 --

2 --

3 RECALL

If softkey RECALL is pushed, the front number which is displayed in the softkey text area is made actual.
This means that the oscilloscope is set according to the front setting that is stored in the front setting memory.
The old front setting is saved in the backup front.
After selection of the FRONT NUMBER menu, the displayed front number can be made actual by pressing softkey RECALL.

4 ENTER>



If softkey ENTER is pushed, the FRONT NMBR/ENTER menu is displayed and a front number between FRO. 01.00 and FRO. 99.99 can be entered using the numeric keypad.
The selected frontnumber is visible in the softkey text area.

4 1 --

4 2 --

4 3 --

4 4 --

4 5 --

4 6 CLEAR

If an error is made, the selected front number can be cleared by pressing softkey CLEAR.

4 7 --

4 8 EXECUTE

By pressing softkey EXECUTE the selected front number is recalled and a RETURN is performed resulting in the display of the FRONT NUMBER menu.
If EXECUTE is pressed after CLEAR the previous front setting remains.
The number is tested against the real setting memory and if the number does not exist or can not be selected, one of the following messages

Selected front doesn't exist.
FRONT number not changed.

or

FRONT 0 cannot be selected because it is
the actual front panel setting.

or

Front number cannot go beyond 99.

can be displayed.

5 NEXT

The action of the softkey NEXT depends on the MAIN SEQ setting.

If softkey NEXT is pushed, while SEQ is active, the next higher front number of the selected sequence is displayed in the softkey text area and made actual.
If NEXT goes to a number after the end of the sequence, the first front in the sequence will be made actual and a message

End of sequence detected.
First front of sequence is selected.

is displayed.

If there is only one front in the sequence and softkey NEXT is pushed, a message

There is no sequence to this main front

is displayed.

If softkey NEXT is pushed, while MAIN is active, the next higher main front number is displayed in the softkey text area and made actual.
If there is only one main front programmed, a message

There is only one main front in the memory.

is displayed.

At all NEXT actions the old front setting is saved in the backup front.

6 PREVIOUS

The action of the softkey PREVIOUS depends on the MAIN SEQ setting.

If softkey PREVIOUS is pushed, while SEQ is active, the next lower front number of the selected sequence is displayed in the softkey text area and made actual.
If PREVIOUS goes to a number before the begin of the sequence, the last front in the sequence will be made actual and a message

Begin of sequence detected.
Last front of sequence is selected.

is displayed.

If there is only one front in the sequence and softkey PREVIOUS is pushed, a message

There is no sequence to this main front

is displayed.

If softkey PREVIOUS is pushed, while MAIN is active, the next lower main front number is displayed in the softkey text area and made actual.
If there is only one main front programmed, a message

There is only one main front in the memory.

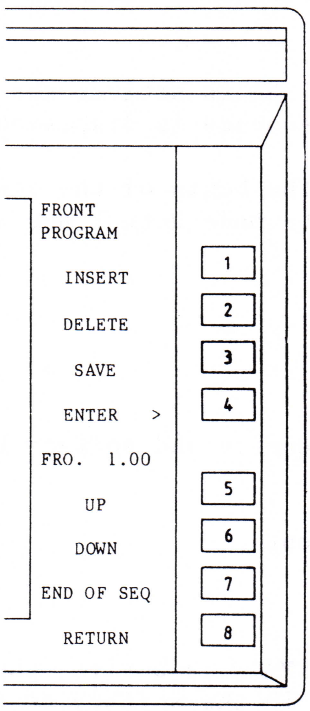
is displayed.

At all PREVIOUS actions the old front setting is saved in the backup front.

7 MAIN SEQ

With this softkey a selection can be made of the actions of the NEXT and PREVIOUS softkeys. These softkeys can step between main fronts (MAIN) or between fronts in a sequence (SEQ).
Pushing the softkey changes the selection from SEQ to MAIN or reverse. The active selection is displayed intensified.

8 PROGRAM>



If softkey PROGRAM is pushed, the menu FRONT PROGRAM will be visible on the screen and new front setting sequences can be programmed or existing sequences can be altered.

Depending on the number of programmed fronts, a part of the softkey texts may not be displayed.

8 1 INSERT

If softkey INSERT is pushed, the actual front setting is inserted after the front number which is displayed in the softkey text area. Next the number of the inserted front is displayed.
When the new front setting is inserted, all higher front numbers are increased by one.

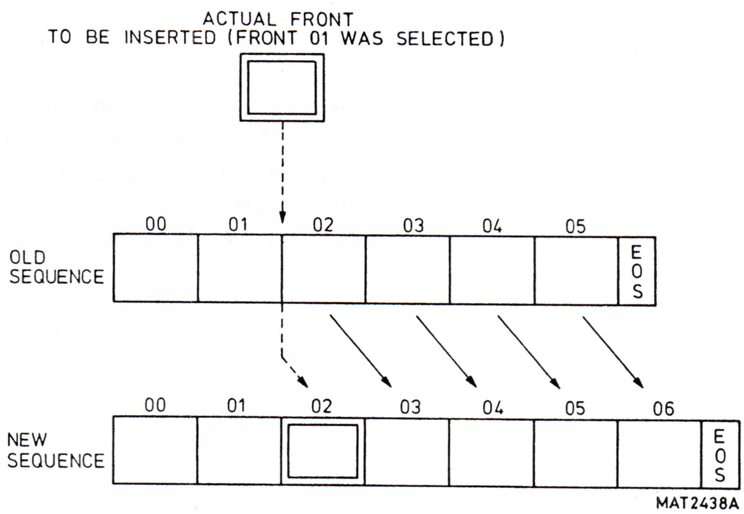


Figure 4.36 INSERT-action.

If there is not enough room in the front setting memory, a message

Not enough memory to SAVE or INSERT front.
DELETE a front before continue.

is displayed.

8 2 DELETE

If a programmed front setting should be removed from a sequence, the number of this front setting has to be selected first.
After pressing softkey DELETE, the selected front setting is removed from the sequence and all higher front numbers are decreased by one.
The deleted front setting is saved in the backup front.

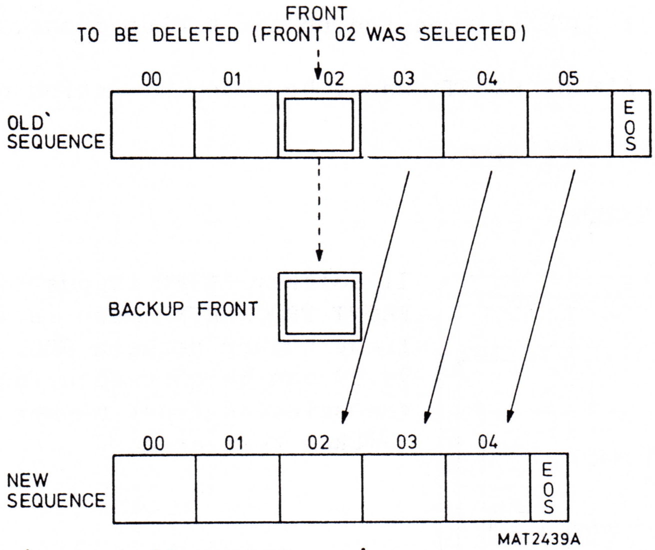


Figure 4.37 DELETE-action.

NOTE: If a main front number is deleted, the complete sequence of fronts is deleted!

8 3 SAVE

If SAVE is depressed, the actual front setting is saved under the number which is visible in the softkey text area.
SAVE can only be used to create a main front or to overwrite an already existing front.
The overwritten front setting is saved in the backup front.

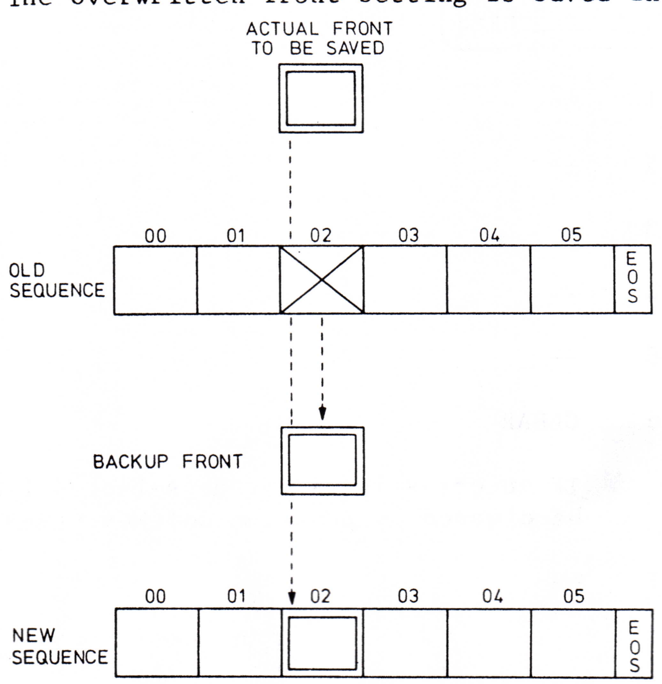


Figure 4.38 SAVE-action.

If there is not enough room in the front setting memory, a message

Not enough memory to SAVE or INSERT front.
DELETE a front before continue.

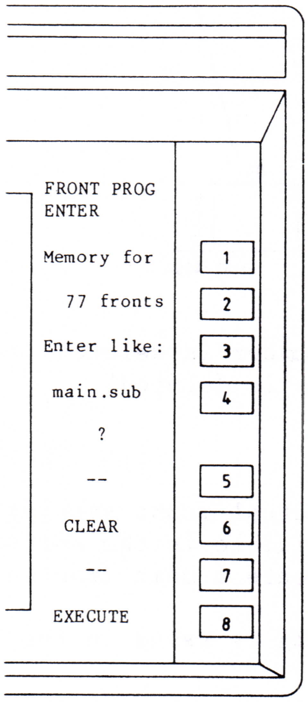
is displayed.

If SAVE is executed on the backup front, a message

BACK UP FRONT cannot be changed. Action not executed

is displayed.

8 4 ENTER>



If softkey ENTER is pushed, the FRONT PROG/ENTER menu is displayed and a front number between FRO. 00.00 and FRO. 99.99 can be entered using the numeric keypad. The selected front number is visible in the softkey text area.

8 4 1 --

8 4 2 --

8 4 3 --

8 4 4 --

8 4 5 --

8 4 6 CLEAR

IF an error is made, the selected front number can be cleared by pressing softkey CLEAR.

8 4 7 --

8 4 8 EXECUTE

By pressing softkey EXECUTE the selected front number is entered and a RETURN is performed resulting in the display of the FRONT PROGRAM menu. If EXECUTE is pressed after CLEAR the previous front setting remains.

If a selected front number does not exist, a message

Selected front doesn't exist.
Number set at last available front in sequence.

is displayed and the last front number in the sequence is selected.

8 5 UP

By pressing softkey UP, the next higher front number of the selected sequence is displayed in the softkey text area. UP functions until the EOS (END OF SEQUENCE) is reached.
Then the following message

Begin or end of the sequence reached.

is displayed.

8 6 DOWN

By pressing softkey DOWN, the next lower front number of the selected sequence is displayed in the softkey text area. DOWN functions until the first front is the sequence is reached.
Then the following message

Begin or end of the sequence reached.

is displayed.

8 7 END OF SEQ

If softkey END OF SEQ is pushed, the selected front number becomes the last front number in the sequence and all the fronts after the selected front are deleted.

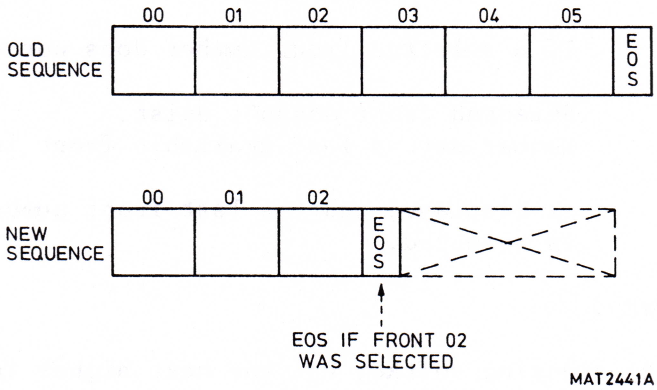


Figure 4.39 END OF SEQUENCE action.

NOTE: There is no way to restore the fronts that are deleted by the END OF SEQ action.

8 8 RETURN

If softkey RETURN is pushed, the FRONT NUMBER menu is displayed again.

In a number of situations an old front setting is saved in the backup front. This backup front can be made actual again by entering the FRONT NMBR/ENTER menu, keying 9999 and pressing the softkey EXECUTE.

The backup front can also be used to restore a front, which is deleted by mistake.
The example below shows how to do this.
It is assumed that front 13.13 is just deleted by mistake in the FRONT PROGRAM menu.

Key	Comment
RETURN	Return to FRONT NUMBER menu.
ENTER	Enter FRONT NMBR/ENTER menu.
9999	Key backup front number.
EXECUTE	Make backup front actual and return to FRONT NUMBER menu.
PROGRAM	Enter FRONT PROGRAM menu.
ENTER	Enter FRONT PROG/ENTER menu.
13.12	Key front number minus one.
EXECUTE	Call front number 13.12 and return to FRONT PROGRAM menu.
INSERT	Insert actual front behind front number 13.12; so at 13.13.

4.2.12 MISCELLANEOUS FUNCTIONS AND REMOTE MODE

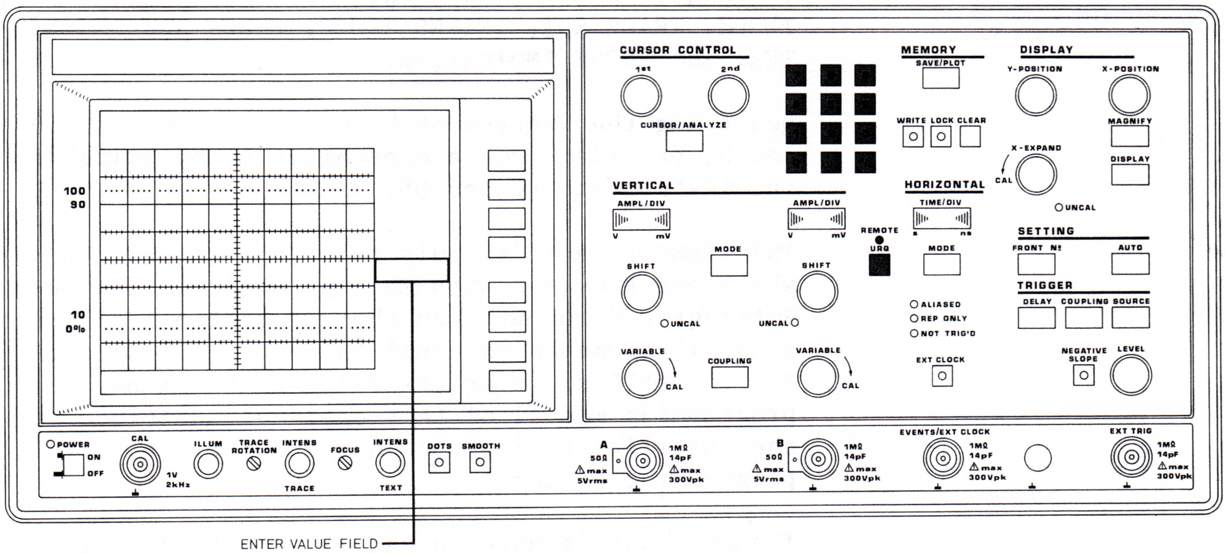
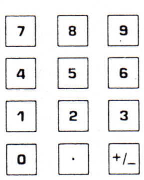


Figure 4.40 Front panel view.



Numeric key pad for data entering after selection of one of the following ENTER functions.

ENTER VERTICAL OFFSET A	4.2.5.2
ENTER VERTICAL OFFSET B	4.2.5.2
ENTER TRIGGER EVENTS	4.2.7.1
ENTER TRIGGER DELAY	4.2.7.1
ENTER SCALE FACTOR	4.2.8.1
ENTER DELAY CHANNEL	4.2.8.1
ENTER FRONT NUMBER	4.2.11.1

If an ENTER menu is selected, the data selected via the numeric keypad will be displayed in the ENTER VALUE FIELD of the softkey text area. Pushing softkey CLEAR, clears this enter value field. If too many digits or a too high value is entered, an automatic clear is performed and a message.

Too many digits: total entry is cleared.

is displayed.

The data entered via the numeric key pad, is activated after pressing softkey EXECUTE.

Pilot lamp indicating that the instrument is in its REMOTE-state and that an (optional) interface overrules all the manually selected front panel settings. The last with the exception of POWER ON, ILLUM, TRACE ROT, INTENS TRACE, FOCUS and INTENS TEXT and PROBE INDICATION.

Resetting the instrument back to its LOCAL-state can be provided from a controller or by switching the instrument OFF and ON.

This REMOTE facility only functions in instruments which are provided with an (optional) interface. Settings and outputs can then be controlled by other instruments external to the oscilloscope. For an optional interface refer to the separate programming manual of this optional interface for the installation instructions and for the programming protocol.

The operator is able to ask an installed option for service by pushing the URQ (user request) pushbutton.
The kind of service which is given then depends on the user's program.

4.2.13 REAR PANEL

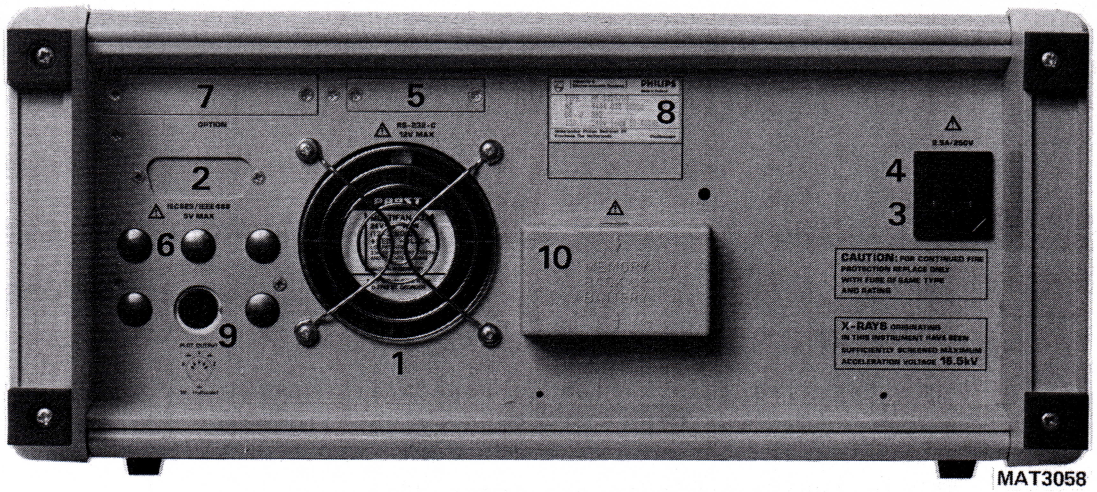


Figure 4.41 Rear panel view.

1 - Fan.

2 - Space for IEEE connector.

3 - Mains input socket (90 V ... 264 Vac, 45 Hz ... 440 Hz). For safety instructions, read section 3.2.2.

4 - Mains fuse holder (Fuse rating 2.5 A delayed action). For safety instructions, read section 3.2.2.

5 - Space for RS-232C connector.

6 - Space for optional BNC sockets.

7 - Space for optional connector.

8 - Type plate with 12-number code and type number.

9 - Analog plot output socket.

10 - Memory back - up battery compartment with removable cover. For installation instructions, read section 3.3.

4.3 DETAILED OPERATING INFORMATION

4.3.1 Introduction

Before switching on, ensure that the oscilloscope has been installed in accordance with the instructions given in Chapter 3 and that the various precautions outlined have been observed.

The following sections give more detailed information regarding the specific functions of the instrument.
It also gives a suitable starting routine before any measurements are made.
Before reading this chapter, it is recommended that Chapter 4.2., explanation of controls and sockets, is read first.

This detailed information is especially useful for those operators who are not familiar with this type of oscilloscope.

The following subjects are described:

4.3.2 Start-up procedure

Switch the instrument on, check that the power-on lamp is on and that the power-up routine is executed.

At the end of the power-up routine, the instrument is ready to accept input signals on the channel A and B input sockets.

Pushing pushbutton AUTO-SET will set the instrument for a triggered display on the C.R.T. screen. The INTENS controls can be set for a suitable trace and text intensity.

The channel A and B signals are stored now in register R0, which is one of the four internal registers R0, R1, R2 and R3, and the contents of register R0 are displayed. Eight of the ten vertical divisions are visible on the C.R.T. screen.

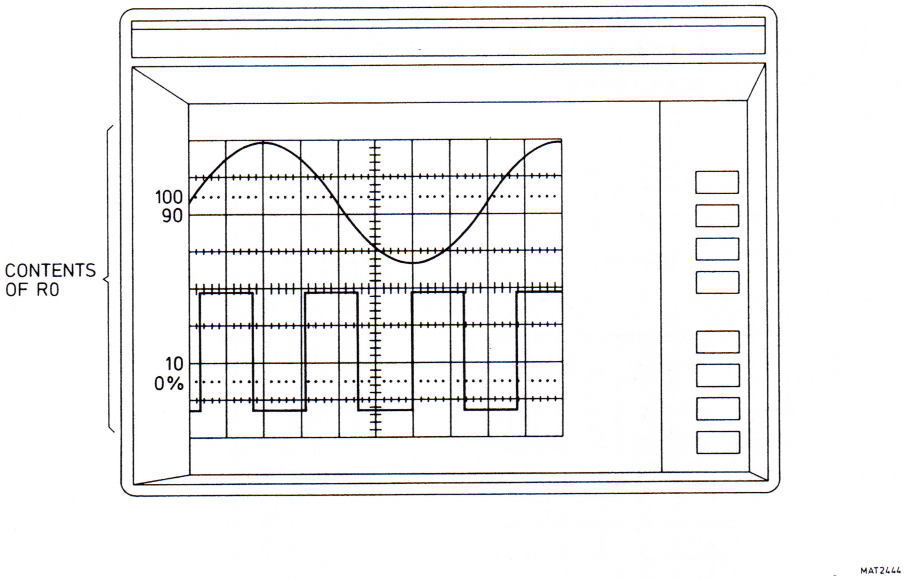


Figure 4.42 Screen of R0 contents in dual channel mode.

Both signals can vertically be shifted over the screen using the (softkey selectable) OFFSET via the VERTICAL COUPLING menu or the input SHIFT (frontpanel control) facilities.
The signal amplitude and the number of displayed periods can directly be influenced by the AMPL/DIV controls and the TIME/DIV control. The selected settings can be read in the top text area on the C.R.T.

4.3.3 Use of internal registers

The procedure to save information in the internal registers or to clear the contents of these registers is now described.

Four internal registers R0, R1, R2 and R3 are available and in each of these registers a signal from channel A as well as a signal from channel B can be stored.

New signal information will always be stored in register R0 and the contents of this register can later be saved, if required, in one or more of the other three registers R1, R2 and/or R3 using the SAVE/PLOT menu by pressing the SAVE/PLOT pushbutton.

Using the DISPLAY menu by pressing pushbutton DISPLAY, gives the facility to the user to select one or more of the four internal registers to display their contents on the CRT screen.
Then displayed signals are overlapping each other on the screen.

To avoid this, the MAGNIFY menu can be selected by pressing pushbutton MAGNIFY to select the Y/5 magnify mode which results in the following display of four registers.

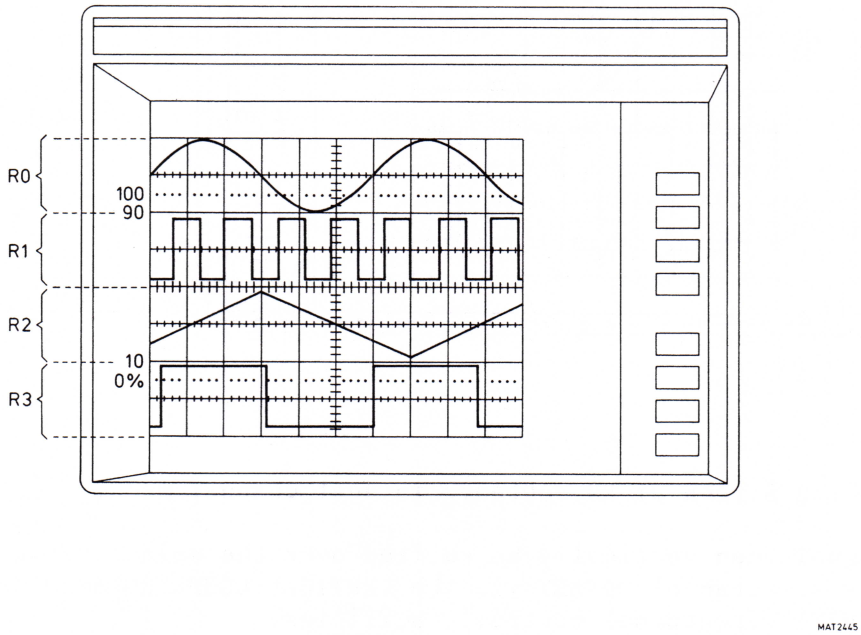


Figure 4.43 Display of four registers in Y/5 mode.

The memory system can be locked by depressing pushbutton LOCK and from that moment on no new signal acquisition can take place.
By depressing pushbutton WRITE, the system can be enabled again for new signal acquisition.

Register R0 can be cleared (in WRITE-mode only) using the CLEAR pushbutton.
The other registers can be cleared hen by saving the cleared contents of register R0 in the selected register. In other words, clearing a register R1, R2 or R3 can be done by saving the blank contents of register R0 in the selected register.

4.3.4 Use of probes

To obtain a suitable connection between the oscilloscope and the device under test a probe is often used.

1:1 passive probes should only be used for d.c. and low-frequency signals. The capacitive loading of these probes attenuates high frequencies or increases the rise-time of signals to be measured (depending on the source impedance).

10:1 and 100:1 passive probes have smaller capacitive loading and are therefore better suited to measurements at higher frequencies. Against this, it may be a disadvantage that they decrease the sensitivity respectively by a factor of 10 and of 100.

For measurements at very high frequencies the high impedance probes are less suitable, due to reflections in the probe cable. This can be avoided by using probes with an input impedance of 5 kOhm and an attenuation factor of 100x. These probes have a very low capacitive loading, but a high resistive charge (5 kOhm).

FET active probes are superior, especially when measurements are to be taken from high impedance test points at the upper frequency limit of the oscilloscope bandwidth. Probes of this type have a very low capacitive loading, yet do not reduce the sensitivity.

10:1 and 100:1 passive probes must be properly compensated before use. Incorrect compensation leads to pulse distortion or amplitude errors at high frequencies.

For correct adjustment of the 10:1 attenuator probes delivered with this oscilloscope, refer to Section 8.1.1.4.

For more details about the available PHILIPS probes contact your local PHILIPS sales organisation.

4.3.5 Input coupling AC, 0, DC

The signals under observation are fed to input socket A and/or B and the AC, 0, DC coupling is set to either AC or DC depending on the compensation of the signal. As the vertical amplifier is d.c.-coupled, the full bandwidth of the instrument is available, and d.c. components are displayed as trace shifts if DC is selected. This may be inconvenient when small signals superimposed on high d.c. voltages need to be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. This is remedied by using AC coupling, which employs a blocking capacitor to suppres the d.c. and l.f. signals. However, some pulse droop will occur when l.f. square-wave signals are displayed.

The 0 coupling interrupts the input signal and grounds the amplifier input, thus providing a quick check of the 0 V reference level.

4.3.6 OFFSET and SHIFT

The OFFSET (before attenuator) facility, which can be operated via the VERTICAL COUPLING menu, can be used to bring channel A and channel B roughly at the same DC level, so that a better use can be made of the vertical resolution.

The SHIFT (after attenuator and before memory) frontpanel controls can be used to adjust the channels against each other with an even better resolution.

4.3.7 Add mode and common mode measurements

If the ADD mode is selected, the signal voltages of both vertical channels are added.
Depending on the selection of the INVERT-mode of the A or B channel, either the sum or the difference of the input signal is displayed. The ADD mode also enables differential measurements to be made. With these measurements, advantage is taken on the common mode rejection in the ADD mode. When the channel B is selected for inversion (and channel A INVERT not activated), the common mode portions of the signals on input sockets A and B will only be subjected to very slight amplification compared with the differential mode portions (see Fig. 4.44).
In measurements where signal lines carry substantial common mode signals, e.g. hum, the differential mode will largely cancel out these signals and leave the remainder of interest (A-B). The capability of the oscilloscope to suppress common mode signals is given by the Common Mode Rejection (CMRR) factor. To obtain the degree of common mode rejection as specified, channel A and B gains must first be equalised. This can be done by connecting both channels to the CAL output connector, and adjusting one of the vertical VARIABLE controls for minimum deflection on the screen.

When passive attenuator probes are used, a similar equalisation process is recommended by adjusting their compensating control for minimum deflection.

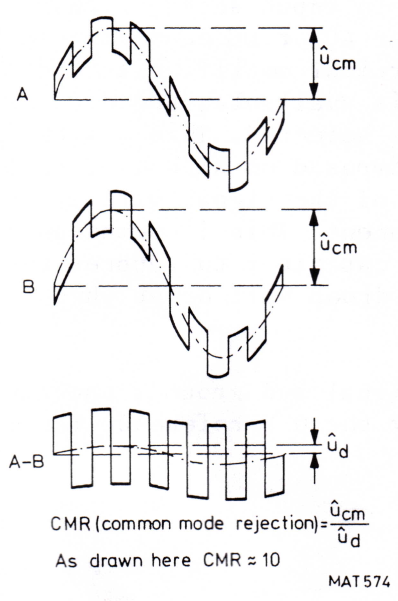


Figure 4.44 Suppression of common mode signals.

4.3.8 Triggering

Trigger sources

The acquisition system can be triggered on signals which are derived from the vertical channels A and B. If two time-related signals are displayed via channels A and B, a stable display is obtained if the trigger source is the signal with the lower frequency.

The acquisition system can also be triggered on a signal which is applied to the external trigger input socket EXT TRIG. This input can be set for two different sensitivities EXT or EXT:10.

If LINE triggering is selected, the trigger signal is directly derived from the mains voltage and has the same frequency as the mains voltage. This trigger mode is usefull, for instance, when examining the mains voltage ripple on the d.c. output voltage of a power supply.

Trigger filters.

Trigger filters can be applied for the selected trigger source. The following filter modes can be selected: DC, AC, LF Reject, HF Reject + AC and HF Reject + DC.

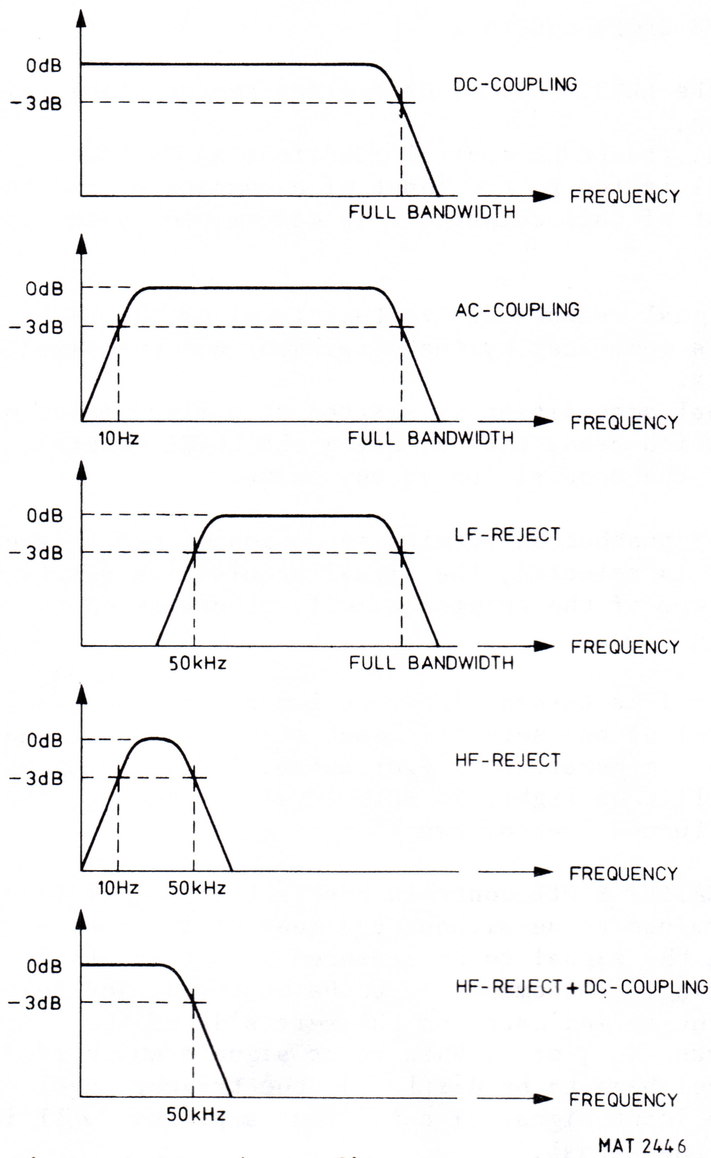


Figure 4.45 Trigger filter responses.

- With DC selected, the full bandwidth of the trigger channel is available.

- With AC selected, the lower frequency range of the trigger channel is limited to 10 Hz. This is achieved by introducing a d.c. blocking capacitor into the signal path. This mode is recommended when triggering on an a.c. signal that is superimposed on a high d.c. voltage.

- With LF Reject selected, the trigger signal path is a.c.-coupled and signals with a frequency lower than 50 kHz are blocked by a high-pass filter. This mode is useful for triggering on an h.f. signal that is polluted with l.f. noise (e.g. hum).

- With AC and HF Reject both selected, the trigger signal path is a.c.-coupled and signals with a frequency higher than 50 kHz are blocked by a low-pass filter. This mode is advisable by high-frequency noise.

- With DC and HF Reject both selected, the trigger signal path is d.c.-coupled and provided with a low-pass filter which blocks signals with a frequency higher than 50 kHz.

LEVEL and NEGATIVE SLOPE controls

The position of the LEVEL control determines the starting point of the signal acquisition.
The circuit behind the LEVEL control functions as follows:
The trigger signal is fed to the input of a comparator and the voltage on the other input of this comparator is determined by the position of the LEVEL control.

If the trigger signal reaches the voltage level of the LEVEL control, a trigger pulse is generated by the comparator and the signal acquisition starts.
In this way, signal acquisition is started at a fixed point of the trigger signal, which means that by using the LEVEL control, it is possible to start the acquisition at any point.

The NEGATIVE SLOPE pushbutton permits selection of the trigger slope. If NEGATIVE SLOPE is selected, the signal acquisition starts on the negative-going slope of the trigger signal, otherwise on the positive-going slope.

If the LEVEL control is turned higher or lower than the maximum resp. minimum level of the selected input signal, the internal comparator does not generate a trigger pulse. The led "NOT TRIG'D" on the frontpanel will then light. In AUTO level triggering, the trigger level can not be turned "out of range".

The LEVEL and NEGATIVE SLOPE controls enable the trigger level to be set at a predetermined value without the need of an input signal. This is important when the signal to be measured is not available in advance as when single phenomena are to be observed. The selected trigger level point is indicated on the left side of the C.R.T. screen by one of the marks ,I , or . When input signals which exceed a known trigger level have to be displayed, the trigger level can be set in advance and an input signal of sufficient amplitude will initiate the recording of the signal.

When external triggering is selected, the I is replaced by an X. For line triggering an L is used as trigger level indication. Both the X and the L do not indicate the exact trigger level, related to the signal, but give an indication where the triggerlevel is set.

AUTO triggering

The acquisition system becomes free running 100 ms after the last trigger pulse. This means that even during the absence of trigger pulses the RØ contents is refreshed, although the pilot lamp NOT TRIG'D lights. If a trigger is again applied, normal triggering is obtained. The lamp NOT TRIG'D will extinguish.
An additional feature of the AUTO mode is that the LEVEL range lies within the peak-to-peak value of the signal amplitude.
Due to the fact that the system becomes free-running 100 ms after the last trigger pulse, the AUTO-mode can not be used for signals with a repetition rate of 100 ms or more; for this the triggered mode must be selected.

DUAL triggering

By selecting DUAL triggering, the oscilloscope is able to trigger on either positive or negative-going edges of the signal. This feature can very well be used in the SINGLE-shot mode.

4.3.9 Trigger delay

TIME DIV positive trigger delay:

Range in 360 s/div ... 200 ns/div : 1 ... 9999 div

Range in 100 ns/div ... 5 ns/div : 1 ... 500 div

With the trigger delay facility the time (in time or divisions) between triggering and the start of the C.R.T. display (left-hand side) can be selected.

Example:

Suppose the 6th line in a TV pattern is desired (TV line = 64 us).

The required trigger delay is therefore 5 x 64 us = 320 us (i.e. after the 5th line has been passed).

- Select TVF triggering.
- Set the TIME/DIV switch to position 10 us/div.
- Select a trigger delay of 320 us or 32 divisions.

A delay of 320 us between the frame pulse and the left-hand side of the C.R.T. display is now obtained.
This results in a display of the information of the 6th line.

TIME DIV negative trigger delay:

Range in 360 s/div ... 5 ns/div : -10 div

With negative trigger delay (pretrigger), selected, the trigger point can be chosen all over the ten horizontal divisions of the CRT screen. This enables to look at what happened before the trigger moment.

NOTE: If the TIME/DIV switch is set to another position, the setting of a positive trigger delay in divisions or a negative trigger delay in time, will be automatically changed (recalculated) and displayed in the top text area. The recalculation is done in such a way that a positive trigger delay remains constant in time and a negative trigger delay (pretrigger) remains constant in divisions. The result of the recalculation is rounded off downwards.

EVENTS trigger delay

Range : 1 ... 9999 events

In this mode which can be selected via the TRIGGER DELAY menu, the trigger can be delayed by a number of events before a new signal acquisition is started.

These events have to be applied to the EVENTS/EXT CLOCK BNC input socket on the frontpanel. The selected level on which these events are detected, is indicated in the TRIGGER COUPLING EV/EXT CLOCK menu. It is also indicated by a mark E on the left side of the C.R.T. Two predeterminded values can be selected by softkeys: TTL and ECL level.

The number of events to be counted can be selected via the TRIGGER DELAY menu.
Event counting is started at the arrival of a trigger signal.

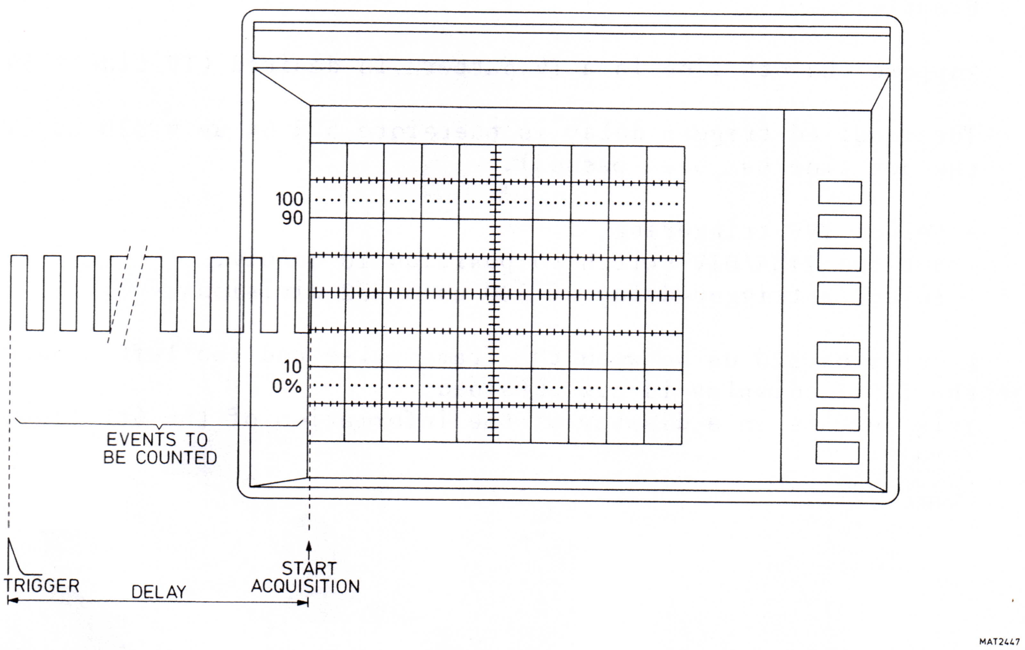


Figure 4.46 Triggering after a number of events.

4.3.10 Time-base modes

4.3.10.1 RECURRENT mode (5 s/div...5 ns/div)

This is the normal time-base mode in which the contents of register R0 is continuously refreshed on the receipt of new incoming trigger signals.

The RECURRENT mode can be divided in two ranges:

- Direct mode (5 s/div...200 ns/div)

  From the incoming signals samples are taken real time and converted into digital codes which are placed in register R0.

- Random sampling mode (100 ns/div ... 5 ns/div)

  Incoming signals are converted into digital codes by using a time converting sampling method.
  Only repetitive signals can be converted, which is indicated by the pilot lamp REP ONLY.

Direct mode single channel

In the time base range 5 s/div ... 1 ms/div, a sweep consists of 4096 samples, which are placed in register R0.
The first 4000 samples are displayed over 10 divisions on the screen.
In the time base range 500 us/div ... 200 ns/div a sweep consists of 512 samples, but register R0 still contains 4096 locations.
The samples are placed on register locations 0, 8, 16, 24, etc., The other locations are filled with "samples" which are calculated by means of interpolation.
The interpolated samples are not displayed, if DOTS is on. This can be made clearly visible by using the *64 HORIZONTAL EXPAND factor via the MAGNIFY menu.

Direct mode dual channel

In dual channel mode, register R0 consists of 2x 2048 locations. (2048 locations per channel).
Now, 2048 samples are taken simultaneously on each channel and placed in register R0.
The first 2000 samples of each channel are displayed over 10 divisions on the screen.
In the time base range 500 us/div ... 200 ns/div a sweep consists of 2 x 512 samples.
Now the samples are placed on register locations 0, 4, 8, 12 and so on. The other locations are filled with interpolated "samples" and not displayed if DOTS is on.

In the time base range 500 us/div. ... 200 ns/div. the interpolated samples can be replaced by real samples if the input signal has a repetitive character. This is called MAXIMUM RESOLUTION.
If MAXIMUM RESOLUTION is selected, the pilot lamp REP ONLY is on.

In single channel mode the first sample of a sweep can be placed on location zero, as well as on location seven. To determine on which location the first sample should be placed, the time which elapses between the trigger pulse and the first sample pulse is measured by the internal delta-t circuit. A very short time results in placing the first sample on the first location, a longer time results in placing the first sample in a higher location. (see fig 4.47).
During the next sweep, again 512 samples are taken and placed in the register. If the samples are placed on locations where already has been placed a sweep of samples, the old samples are overwritten.
If AVERAGE is selected, the old sample and the new sample are used to calculate a new sample (see also section 4.3.12).
So it takes at least 8 sweeps, but probably more, to make a complete picture.

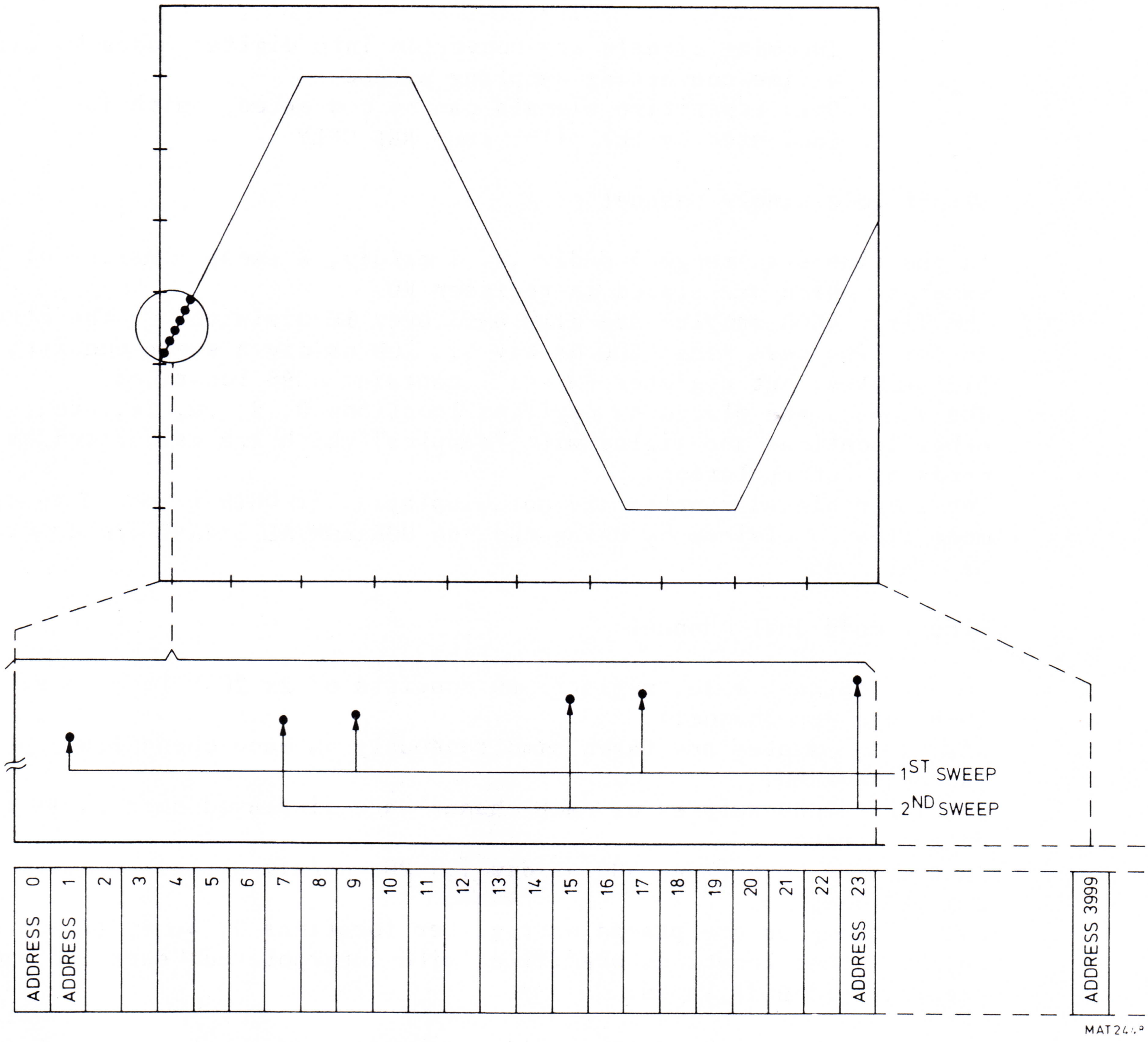


Figure 4.47 Maximum resolution mode after two sweeps.

In dual channel mode there are four possibilities to place the sweeps in register R0.
Once again the time that elapses between the trigger pulse and the first sample pulse is used to place the samples at the right locations.

If AVERAGE is selected in the time base range 500 us/div ... 200 ns/div, the instrument automatically selects the MAXIMUM RESOLUTION mode.
When MIN / MAX is selected, the MAXIMUM RESOLUTION mode is automatically switched off.

NOTE: In maximum resolution mode at least 8 sweeps (or 4 in DUAL channel mode) are needed to make a complete picture. In this way, a high resolution display with low jitter is realised. This also means that, if the input signal changes, there is temporarily a situation of change over, which looks quite strange. This effect becomes more strongly visible when the AVERAGE mode is turned on. Turning SHIFT, VARIABLE or LEVEL, has a similar effect.
After a change of an AMPL/DIV or TIME/DIV setting the register is cleared and a new picture is made. So there are no strange effects visible.

Random sampling mode

In the time base range 100 ns/div...5 ns/div, the random sampling mode is used. This mode allows the digitizing of input signals with high frequencies.
These frequencies may be even higher than the sampling and conversion rate. It is possible to digitize a 200 MHz signal with the sample and conversion rate of 50 Msamples/s.
To get a complete picture one condition should be met: the signal has to be repetitive.

The principle is a follows (see fig. 4.48):
After a trigger occurs, the time which elapses between the trigger pulse and the first sample pulse is measured by the delta-t circuit. Afterwards, a number of samples, depending on the time base setting, is taken and converted.
E.g. with the sampling rate of 50 Ms/s every 20 nsec a sample is taken. With a time base setting of 10 nsec/div a sweep takes 100 nsec. So 100/20 = 5 samples can be taken during one sweep.

The locations in the register, where these samples have to be stored depend on the measured time between the trigger pulse and the first sample pulse.
The next sweep another 5 samples are taken and placed in register R0 and on the C.R.T. screen. Because there is probably another time difference between the trigger pulse and the first sample pulse, the samples are placed on other places in the register and so they make the picture more complete. To make a complete picture of 500 dots, at least 100 sweeps (in this example) are needed, but probably more.The more dots that there are already filled in, the bigger the chance is that a new sweep overwrites a previous sweep.
A complete picture consists of 500 dots over 10 divisions (512 samples in register R0) in single channel mode and of 2x500 dots over 10 divisions (2x512 samples in register R0) in dual channel mode.
If DOTS is off intermediate dots are calculated and displayed in the same way as in the direct mode with the MAXIMUM RESOLUTION mode off.

Because there are samples taken and stored in the oscilloscope before the trigger pulse occurs, pretrigger is also possible.
The urgency of a repetitive signal as input signal will be clear now.

NOTE: When the input signal changes, the picture on the screen changes in a random way from the old situation to the new one. This looks quite strange for a while, but it is normal because of the random sampling principle.

Because there is no time relation between the trigger pulses, which are derived from the input signal, and the sampling pulses, the time between a trigger pulse and the first sample pulse is random. This is why this principle is called random sampling.

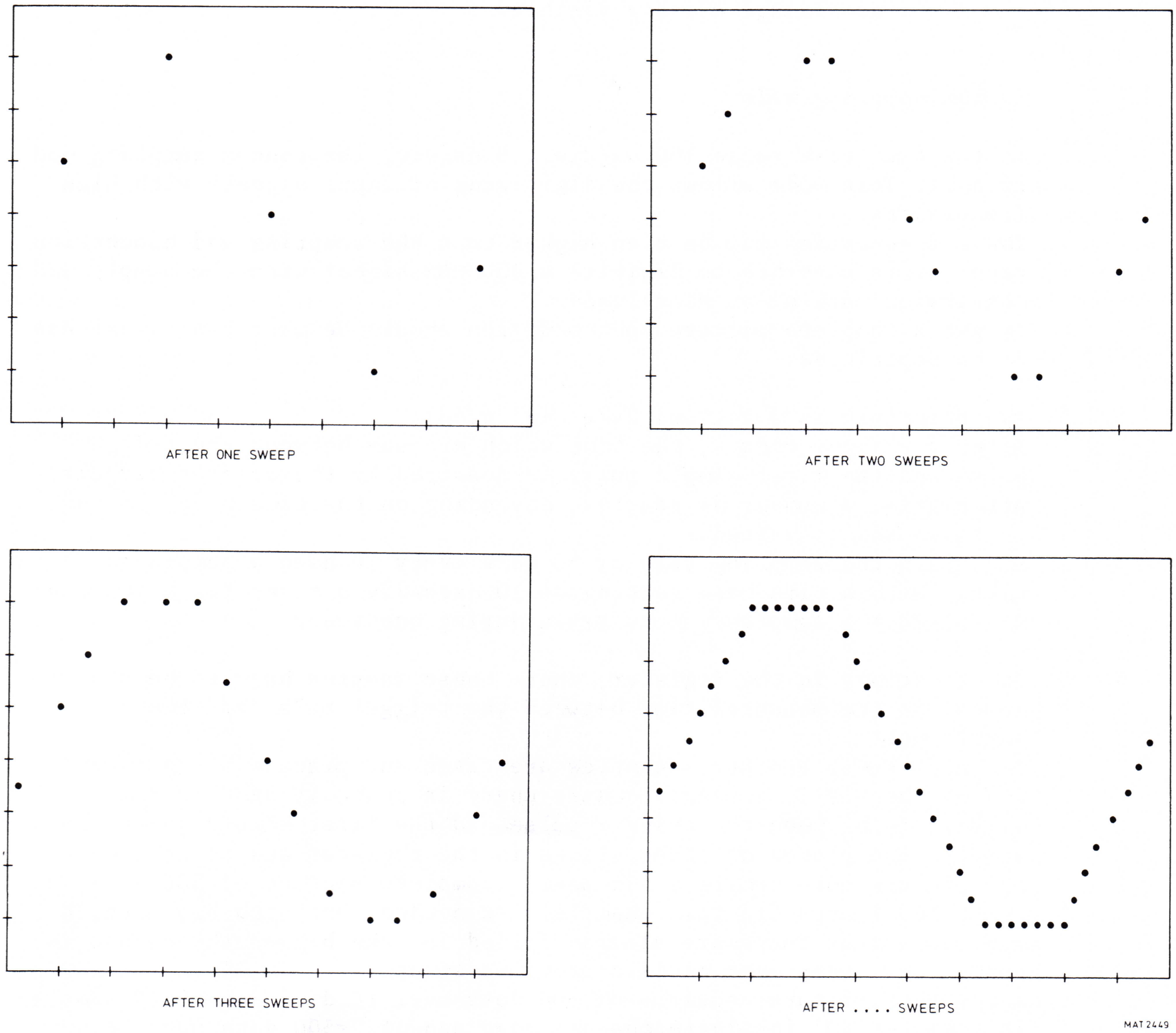


Figure 4.48 Random sampling.

4.3.10.2 SINGLE and MULTIPLE-modes

SINGLE and MULTIPLE shots can be taken in the direct mode (time base range 5 s/div ... 200 ns/div). This is very useful for displaying single phenomena.

SINGLE and MULTIPLE scans can be taken in the random sampling mode (time base range 5 ns/div ... 100 ns/div), and in the direct mode when the MAXIMUM RESOLUTION mode is on (time base range 500 us/div ... 200 ns/div). Then the pilot lamp "REP ONLY" is on.
During a scan there are taken as many sweeps as necessary to make a complete picture on the screen.

When the SINGLE-mode is selected, the contents of register R0 is refreshed once after a trigger pulse and the selected delay-time, and the refreshed contents of register R0 is displayed on the C.R.T. screen.
As long as the instrument is waiting for a trigger pulse, the pilot lamp NOT TRIG'D will light.

When the MULTIPLE-mode is selected, the previously described SINGLE-action is repeated four times. The result of the first SINGLE action in register R0 is copied to register R3, the second result is copied to register R2, the third to register R1 and the fourth stays in register R0. This is independent of the registers being displayed or not.
The number of single actions to be executed is counted down in the top text area on the C.R.T.

When either the SINGLE- or the MULTIPLE-action is not completed, the text ARMD (ARMeD) in the soft-key text area is intensified.

A new shot or scan can be taken by pressing the relevant softkey or the CLEAR pushbutton.

In the time base range 5 s/div...1 ms/div, the resolution is 1x4096 or 2x2048 samples (the same as in RECURRENT mode).
In the time base range 500 us/div...200 ns/div, the resolution is 512 samples per channel at each shot.
The samples are placed in the locations Ø, 8, 16, 24, etc. of register R0. Intermediate samples until 1x4096 or 2x2048 are calculated and not displayed if DOTS if on.
In the time base range 100 ns/div...5ns/div, a scan takes as many sweeps until 512 samples, or 2x512 samples, are taken. Intermediate samples until 1x4096 or 2x2048 are calculated and not displayed if DOTS is on.

4.3.10.3 ROLL mode

The continuous ROLL mode is typically used for very low frequency signals and is effective with TIME/DIV settings from 50 ms/div... 360 s/div. The signal is recorded in register R0 and is built-up point-by-point from the right-hand side of the C.R.T. screen and continuously shifted towards the left.
This mode can be selected via the HORIZONTAL MODE menu and can be started by pressing the RUN/STOP softkey once.

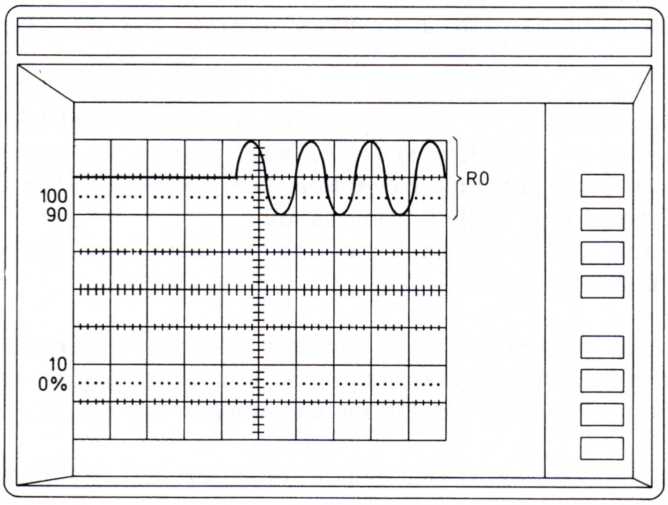


Figure 4.49 ROLL-mode action.

No trigger is needed in this mode.
During the ROLL mode action, the text RUN in the softkey text area is intensified displayed. The ROLL mode can be stopped by pressing the RUN/STOP softkey once again. The text STOP in the softkey area is then intensified displayed.
When TRIG STOP is selected, the ROLL mode can be stopped by a trigger signal. The triggered STOP can be delayed by selecting a trigger delay.
The resolution is 4000 dots over 10 divisions in single channel mode and 2000 dots (per channel) over 10 divisions in dual channel mode.

The ROLL mode can be started again by depressing the RUN/STOP softkey or pushbutton CLEAR.

NOTE: If trigger delay 0 is selected, the trigger (stop) point is at the left side of the screen. This means that after the actual stop signal the screen continues 10 divisions.

4.3.10.4 EXT CLOCK mode

By applying an external clock frequency of max. 50 kHz to the EVENTS/EXT CLOCK BNC input socket and with the pushbutton EXT CLOCK depressed, the user is able to determine the conversion rate.
The internal digital time-base generator is not used then, which is indicated by the text TB EXTERN in the top text area on the C.R.T. screen.

The trigger delay facility still functions but can only be selected in divisions.

Cursor time measurements are not possible, which is indicated by a display in a number of dots (dts) in stead of time.

4.3.11 MIN / MAX mode

In this vertical processing mode which can be selected in the time-base positions 5 s/div...5 us/div and in the ROLL mode, the maximum and minimum signal amplitude over the time between two adjacent input signal samples is measured by two PEAK DETECTORS per channel.
These maximum and minimum signal levels are applied in serial to a TRACK AND HOLD gate via a MULTIPLEXER. This MULTIPLEXER switches between the minimum and maximum PEAK DETECTOR output. This results in peak values MIN - MAX - MIN - MAX - MIN and so on. The output values of the TRACK AND HOLD gate are applied to the ANALOG TO DIGITAL CONVERTER, converted, stored in the digital trace memory and displayed on the C.R.T. screen.

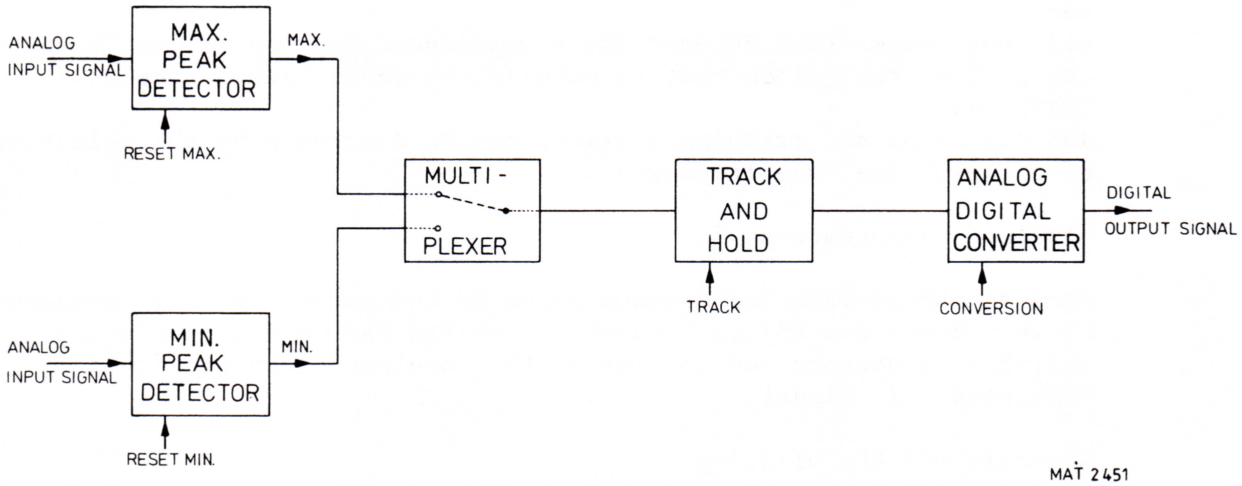


Figure 4.50 Principle of peak detection.

After the moments that a minimum or a maximum is taken over by the TRACK AND HOLD gate before the ADC, the relevant PEAK DETECTOR will be reset.
During this reset cycle (about 20 ns) the PEAK DETECTOR is not able to watch the input signal.

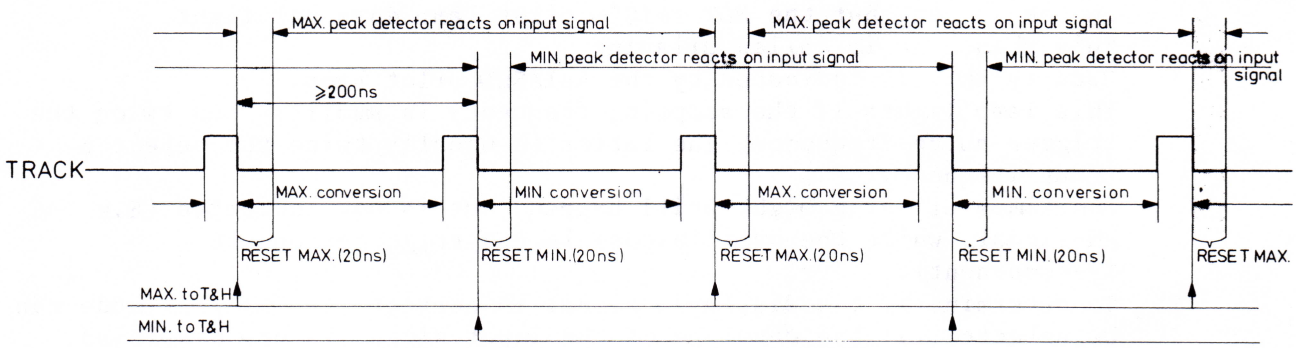


Figure 4.51 Principle of peak detection. MAT 2452

In the time base setting 5 usec/div the sweeplength is 50 us.
A sweep consists of 250 MIN and 250 MAX samples over 10 divisions. So the time between 2 MAX samples is 50/250 = 0,2 us = 200 ns. In this 200 ns the PEAK DETECTOR is during 20 ns blind, due to reset. The blind time ratio is now 10%.
In faster timebase settings, the blind time ratio increases; MIN / MAX can not be used then.
In time base setting 50 us/div, the blind time ratio is 1%.
In time base settings 500 us/div and slower, the blind time ratio is $1^{o}/oo$ or better.

The MIN / MAX mode can be selected for:

- Glitch detection
- Envelope measurements
- Detection of the aliasing

Glitch detection

Glitch detection in a digital storage oscilloscope is usually not possible. By means of the MIN/MAX mode, even glitches with a pulse width of 3 ns are still displayed with an amplitude of about 50%.

If a glitch occurs in the reset time of a PEAK DETECTOR it is not seen.
Glitches longer than 20 nsec are always seen. The amplitudes depend on the part of the glitch that is outside the reset time of the PEAK DETECTOR.
The chance of not catching a glitch can be decreased by the selection of a lower time base frequency.

Envelope measurements

Because the minimum and maximum value of the input signal is measured between every two adjacent samples, the MIN/MAX mode is perfectly suitable to measure and to display the envelope of an Amplitude Modulated r.f. signal.

Detection of the aliasing

In a digital storage oscilloscope the input signal is sampled at a high frequency, to convert the analog signals into digital signals.
This sampling frequency is determined by the time-base setting or by the EXT CLOCK input frequency.
If the frequency of the input signal is almost the same (or a multiple higher) as the frequency of the sampling clock, a low frequency interference signal will be displayed, which seems to be not triggered on the screen, but the NOT TRIG'D pilot lamp does not light.
This phenomena is called aliasing.
Usually this is indicated by the ALIASED pilot lamp.
This lamp lights if the sampling frequency is smaller than twice the trigger pulse frequency. The latter is usually twice the selected input frequency.
Sometimes aliasing might still happen, but is not indicated.(E.g. an AM-signal, while the oscilloscope is EXT triggered on the LF-component).
To determine if the displayed signal is correct, the MIN/MAX mode can be selected. If the envelope of the input signal is now displayed, there was aliasing.
The chance of aliasing can be reduced by selecting an as fast as possible time base setting.

4.3.12 AVERAGE mode

AVERAGING is a way to suppress noise without losing bandwidth and can only be used in RECURRENT mode.
Every dot is calculated after every sweep in the following way:

$$\text{new} = \text{previous} + \frac{\text{measured} - \text{previous}}{C}$$

In this formula "previous" is a sample on the same position of the previous sweep.
If C=1 every new dot is the measured dot; AVERAGE is OFF. If C>1, the dot positions change slower.
The bigger C is, the slower the dot positions change. The following values for C can be selected: C = 2, 4, 8, 16, 32 or 64.

In ROLL mode it is also possible to use AVERAGE.
Between two displayed samples, more samples are taken. These intermediate samples are used to perform the AVERAGE calculation with a fixed value for C of C = 32.

AVERAGE cannot be used together with MIN / MAX.

NOTE: If SINGLE or MULTIPLE SHOT is selected AVERAGE is not effective.

4.3.13 Horizontal magnifier

When the continuous horizontal expand (X-EXPAND) control is used, the display on the screen expands horizontally to more than 2x the TIME/DIV setting. The reduced time window provides a more detailed display. Using the X POSITION control, any portion of the trace can be shifted into the display area.

Via the MAGNIFY menu the following horizontal expand factors can be selected:
*1, *2, *4, *8, *16, *32 and *64.

4.3.14 Vertical magnifier

Via the MAGNIFY menu, three different vertical expand factors, Y/5, Y*1 and Y*5 can be selected.

Y/5

All four registers R0, R1, R2 and R3 can be displayed in their own trace area, each with a vertical trace height of two divisions.

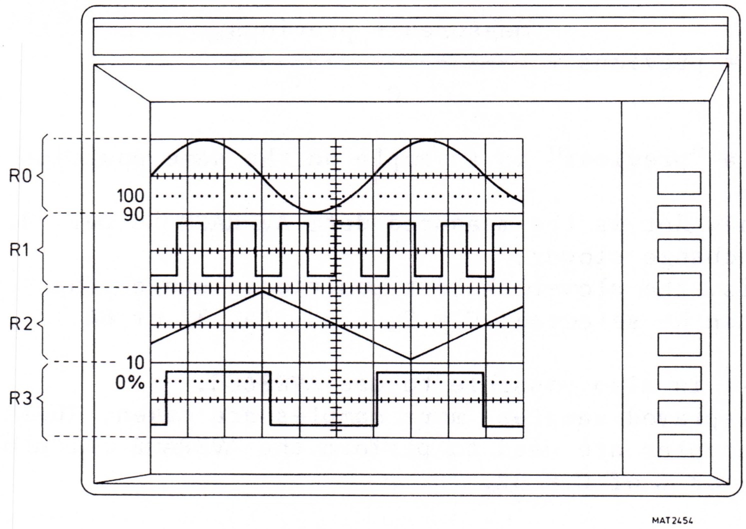


Figure 4.52 Y/5 mode.

In this mode it is also possible to add reduced register texts in the trace area of each register via the DISPLAY menu.

Y*1

This is the normal vertical expand factor, in which each register can be displayed over 10 vertical divisions of which 8 divisions are visible on the C.R.T. screen.

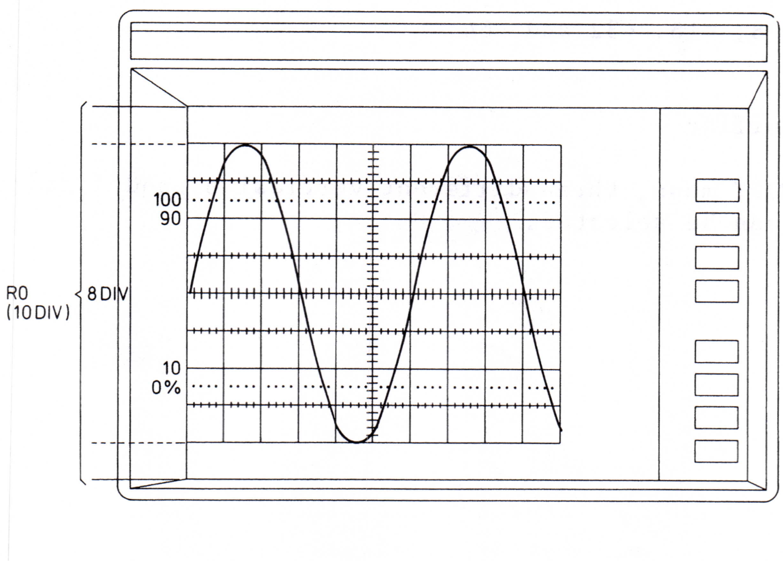


Figure 4.53 Y*1 mode.

Y*5

In this mode a vertical expand from 10 divisions to 50 divisions is possible of which only 8 divisions are visible on the C.R.T. screen.

Using the Y position control, any vertical portion of the trace can be shifted into the trace area of the C.R.T. screen.

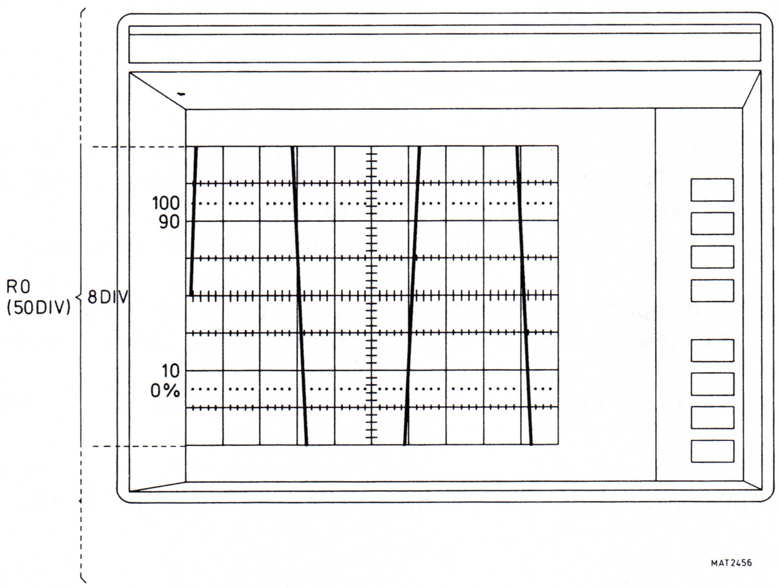


Figure 4.54 Y*5 mode.

4.3.15 A versus B-mode

With a A versus B selected, XY display is obtained from the samples derived from the channel A and channel B inputs.

The samples derived from the channel A input signal are used for horizontal deflecton and the samples derived from the channel B input for vertical deflection.

This A versus B mode is principally a different mode than the real time X-Y mode in a real time oscilloscope.

In this case it is only a different way of displaying the contents of the registers. The storage of signal information is influenced by the position of the TIME/DIV switch, trigger selection and trigger SLOPE and LEVEL, so the A versus B display of this information is also influenced by these factors.

4.3.16 Analog plot mode

Two different PLOT-modes can be selected:

- Register PLOT via the SAVE/PLOT menu:

  The contents of the selected register can be plotted. The Y-POSITION, the X-POSITION, and the X-EXPAND controls and the MAGNIFY selection have no influence.

- Screen PLOT via the DISPLAY menu:

  The picture on the trace area of the C.R.T. screen can be plotted including the influence of the Y-POSITION, the X-POSITION and the X-EXPAND controls and the MAGNIFY selections.
  The picture will be similar to the picture on the screen.

The X and Y plot outputs on the rear panel of the oscilloscope generate 1 V full memory or 1 V full screen. (See characteristics).

The PEN LIFT output is an open collector output; max 12 V (TTL compatible).

Via the SAVE/PLOT menu the following selections can be done.

- PEN UP "0"
- PEN UP "1"
- PLOT speed
  Range: 20 ms/dot ... 2000 ms/dot.
- Register R0, R1, R2 or R3 (only for register PLOT).

During plotting, the oscilloscope is in the LOCK-mode, which means that the contents of all registers cannot be changed.

In case of dual channel plotting, first channel A will be plotted and then channel B.

The PLOT operation is provided with a short delay at the start and end of the action to give sufficient time for manual pen positioning if no automatic pen lift function is available on the recorder.

If the SINGLE-shot mode and register plot is selected, the AUTOPLOT function can be activated.
The contents of register R0 is then automatically plotted after each refreshment of the register when a valid trigger is received.

The progress of the plotting is indicated by a dot on the C.R.T. screen, which moves from the left to the right and which is displayed in the bottom text area.

Figure 4.55 Blockdiagram.

4.4 PRINCIPLE OF OPERATION

In this section, the principles of operation are discussed at block diagram level, with special emphasis being applied to those parts of the circuit that differ from normal oscilloscope practice; i.e. the digital storage and control facilities.

4.4.1 GENERAL

This digital storage oscilloscope comprises the following sections:

- a signal acquisition section which can be divided in a vertical section, a trigger section and a conversion and processing section.
- a storage section
- a display section
- a control section
- a front section
- a power supply section

4.4.2 The signal acquisition section

Vertical section

The input signal(s) to be displayed can be applied to the BNC input sockets A (and) or B.

If the probe delivered with the oscilloscope is used, the attenuator setting of the oscilloscope is adapted to the attenuator factor of the probe via the PROBE DETECTION contacts adjacent to the BNC input connectors A and B.
The channels A and B are identical so only channel A is described.
The applied input signal is fed to the VERTICAL SIGNAL CONTROL via ATTENUATOR A.
In ATTENUATOR A, the vertical sensitivity is determined, controlled by the AMPL/DIV button via the CONTROL SECTION (indicated with C -->).

With the pushbutton COUPLING, a softkey menu is activated which makes selection of the following functions possible:

- input coupling selection : AC-DC-GROUND
- input impedance selection: 1 MOhm - 50 Ohm
- OFFSET selection (via preselected values)

The attenuation can be continuously controlled by the frontpanel VARIABLE control and when active the UNCAL led will be on.
Vertical shift of the trace is determined in the VERTICAL SIGNAL CONTROL by the frontpanel SHIFT control.

The pushbutton MODE makes via the softkeys selection of the following functions possible:

- INVERT A (B)	: inversion of input signal		
- VERTICAL DISPLAY MODES	: A	: only channel A	
	: A and B	: channels A and B	
	: ADD	: A and B added	
	: B	: only channel B	
- BW LIMIT	: bandwidth limiter		
- MIN / MAX	: minimum / maximum mode		

The VERTICAL DISPLAY MODE is selected in the VERTICAL CHANNEL SWITCH which also contains peak detectors to perform the softkey selectable MIN / MAX function.
The selected vertical input signal is then fed to the CONVERSION AND PROCESSING SECTION.

Trigger section

This oscilloscope can be triggered via signals which are internally derived from channel A or channel B or LINE and via an externally applied input signal.

The EXTERNAL trigger signal must be applied to the EXT TRIG. input and is then fed to the TRIGGER SOURCE SELECTOR together with the LINE signal, which is a mains-voltage related trigger signal from the POWER SUPPLY.

In the TRIGGER SOURCE SELECTOR the different trigger sources are selected by the pushbutton (TRIGGER) SOURCE.

When pushbutton SOURCE is pressed, the following trigger sources can be selected via the softkeys:

- A : trigger derived from channel A
- B : trigger derived from channel B
- EXT : trigger derived from EXT TRIG input
- EXT:10 : trigger derived from EXT TRIG input divided by 10
- LINE : trigger derived from the mains voltage

The selected trigger signal is fed to the TRIGGER AMPLIFIER where the trigger coupling, trigger level and trigger slope are determined by respectively the frontpanel controls: COUPLING, LEVEL and NEGATIVE SLOPE.

The pushbutton COUPLING makes via the softkeys the selection of the following functions possible:

- AC-DC AC : DC components are blocked.
  DC : full trigger bandwidth
- AUTO : The level range is determined by the signal amplitude (peak-peak triggering)
- TVF : Television Frame signal synchronisation
- LF reject : LF trigger signals are rejected (up to 50 kHz)
- HF reject : HF trigger signals are rejected (higher than 50 kHz)
- SLOPE + - : trigger slope selection: positive or negative (can also be selected with button NEGATIVE SLOPE)
- DUAL : triggering on both positive and negative slope of trigger signal

The LEVEL control determines the level of the trigger signal on which an output signal is generated to the ACQUISITION AND CONTROL LOGIC, to start the signal conversion.

The AUTO PEAK-PEAK DETECTOR and the TRIGGER LOGIC are controlled for AUTO LEVEL mode (peak-peak triggering) via the MICROPROCESSOR MANAGEMENT INTERFACE.

For AUTO OFFSET mode the mean value of the trigger signal is fed via the MICROPROCESSOR MANAGEMENT INTERFACE to the microprocessor to calculate the AUTO-OFFSET level.

Trigger moments can be delayed by events which can be applied to the EVENTS/EXT CLOCK input socket.
The LEVEL on which these external EVENT signals pass the EVENTS AND EXTERNAL CLOCK circuit is determined by the LEVEL control via the EVENT LEVEL signal coming from the MANAGEMENT INTERFACE.
These EVENTS are fed to an EVENT COUNTER in the ACQUISITION AND CONTROL LOGIC.

The oscilloscope can operate on an external clock signal, which is applied to the EVENTS/EXT CLOCK input socket. The LEVEL on which the external clock signal passes is determined in the same way as the event level. The external clock signal is fed to the ACQUISITION AND CONTROL LOGIC.

Conversion and processing section

In the conversion and processing section the vertical input signals are digitised, processed and stored in a digital memory. This is done by an Analog to Digital Converter, which receives the vertical input signals via a MULTIPLEXER from the VERTICAL CHANNEL SWITCH AND PEAK DETECTORS.
This MULTIPLEXER is provided with track and hold circuits, which can hold samples that are taken from both channels at the same moment.
The samples are converted then in sequence by the ADC.
Data from the ADC is processed by the DATA PROCESSING CIRCUIT, which performs e.g. the softkey selectable AVERAGE function.
Data from the DATA PROCESSING CIRCUIT is transported to the STORAGE SECTION.
The PEAK DETECTORS, MULTIPLEXER and ADC are controlled by the TIME BASE LOGIC, which on its turn is controlled by the ACQUISITION AND CONTROL LOGIC.

The ACQUISITION AND CONTROL LOGIC performs the following functions:

- Time base setting, controlled by the TIME/DIV switch

- Horizontal mode selection by means of the softkey functions under the HORIZONTAL MODE pushbutton.

  - RECURRENT
  - MULTIPLE
  - SINGLE
  - ROLL

- Trigger delay selection by means of the softkey functions under the TRIGGER DELAY pushbutton.

  - TIME
  - DIV
  - EVENTS

- Selection of EVENTS or EXT CLOCK via the frontpanel EXT CLOCK pushbutton.

- Control of pilot lamps ALIASED, REP ONLY and NOT TRIG'D.

The ACQUISITION AND CONTROL LOGIC is controlled by the microprocessor system, which also controls the DATA PROCESSING CIRCUIT.
The DELTA-t circuit is used for the random sampling mode (time base range 100 ns/div - 5 ns/div).
The delta-t output signal is fed to the microprocessor system via the MICROPROCESSOR MANAGEMENT INTERFACE for dot position calculation.

4.4.3 The storage section

After each conversion of a sample into a 10-bits digital code, the code will be stored in a digital memory in the DATA PROCESSING CIRCUIT. The capacity of this memory is 4096 digital values, which is a complete picture of ten horizontal divisions. This memory is configurated as a shift register.
When a number of samples is converted and stored in this digital memory, this memory contents is copied into register R0 of the TRACE MEMORY. The number of samples depends on the time base setting. The addresses for the TRACE MEMORY are generated by the ADDRESS GENERATOR under microprocessor system control.
It is possible to save the contents of TRACE MEMORY register R0 in one of the other registers R1, R2 or R3 by means of the softkey functions under the SAVE/PLOT pushbutton.

Each of the four registers is able to store 4096 digital 10-bit codes in single channel mode. With both input channels ON, each register capacity is equally divided into 2048 digital 10-bit codes for each input channel.

The TRACE MEMORY can be cleared by pushbutton CLEAR, locked by pushbutton LOCK and enabled for new signal acquisition by pushbutton WRITE.

A TEXT MEMORY is also part of the storage section. In this TEXT MEMORY all display texts are stored under microprocessor control.

Cursor control can be operated via the frontpanel controls 1st and 2nd and the softkey menu under the frontpanel CURSOR pushbutton. It is a microprocessor controlled function which uses the contents of the TRACE MEMORY as input for calculations and the determination of the position of the cursors, and which uses the TEXT MEMORY to store the cursors and the calculation results.

4.4.4 The display section

This section controls the display of the contents of registers R0, R1, R2 and R3 as well as the display of text on the CRT screen under the control of softkey functions.
The trace and text data is separated in a vertical and a horizontal component and applied to two signal paths for vertical and horizontal deflection.

Horizontal deflection

Each address of a register corresponds to a specified vertical line of the CRT display along the X-axis; i.e. the display of 10 divisions into 4000 lines.
The address sequence generated by the ADDRESS GENERATOR can be expanded in the HORIZONTAL A versus B / EXPAND circuit and influenced by an additional horizontal position information from the X-POSITION control before they are applied to a HORIZONTAL DIGITAL TO ANALOG CONVERTER.

To provide the discrete steps for the horizontal time base display, the output of the DAC is a linear staircase voltage, which is applied to the horizontal final amplifier via a DOT JOIN / SMOOTH filter and from there to the horizontal deflection plates of the C.R.T.

Via the X-EXPAND DAC an horizontal expand information is applied to the HORIZONTAL FINAL AMPLIFIER for an additional horizontal expand. This information comes from the front panel X-EXPAND control.

Vertical deflection

The contents of each trace register is 4096 10-bit digital codes, each capable of indicating one out of 1024 different signal amplitudes.

These 10-bit digital codes can be inverted or expanded in the VERTICAL INVERT/EXPAND circuit and influenced by an additional position information from the Y-POSITION control before they are converted into the analog representation of the measured input signals by means of a VERTICAL DIGITAL TO ANALOG CONVERTER. From here the signal is applied to the VERTICAL FINAL AMPLIFIER and the vertical deflection plates of the C.R.T. via a VERTICAL DOT JOIN/SMOOTH filter.

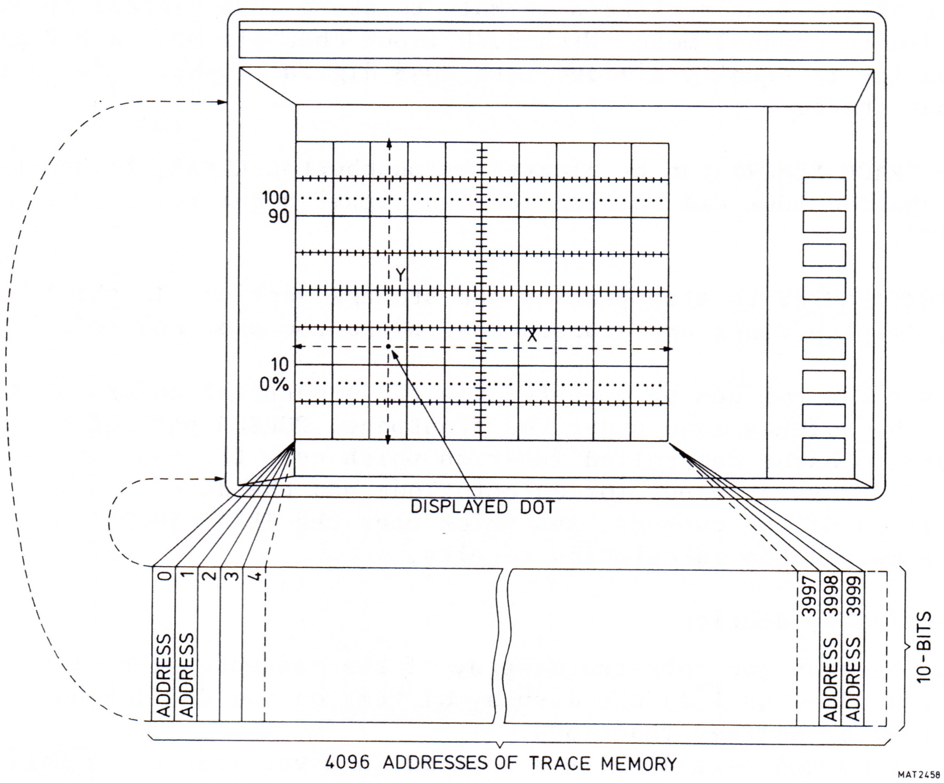


Figure 4.56 Display of trace memory contents.

Display functions

With the pushbutton DISPLAY, a softkey menu is activated which makes selection of the following functions possible:

- Register selection
- POSITION selection: assignment of the frontpanel controls Y-POSITION, X-POSITION and X-EXPAND to a selected register and channel.
- Register INVERT
- A versus B display
- Reduced register text display
- Full register text display

With pushbutton MAGNIFY, a softkey menu is activated for the following functions:

- HORIZONTAL EXPAND *1...*64
- VERTICAL EXPAND Y*5, Y*1 or Y/5

Z-control

The Z trace blanking/unblanking signal for the C.R.T. depends on a number of factors, like register selection, A versus B or X=t display, dot join, text and so on.
The Z-AMPLIFIER is therefore controlled by the microprocessor, a control signal from the vertical and horizontal signal path, the frontpanel INTENSity controls and the frontpanel FOCUS control.

Plot

Signals PLOT X, PLOT Y and PLOT Z are applied to the ANALOG PLOT OUTPUT circuit and from there to the PLOT OUTPUT socket on the rear panel.
Via the SAVE/PLOT menu a "register plot" function can be selected and via the DISPLAY menu a "screen plot" function can be selected.

Cal

A CAL GENERATOR generates a 1 Vpp - 2 kHz signal for calibration purposes.

4.4.5 The control section

The control signals which are routed to the various circuits are indicated with "C -->" for the MANAGEMENT INTERFACE and with "CuP -->" for the MICROPROCESSOR.

A MICROPROCESSOR system including a ROM MEMORY for the system program and a RAM MEMORY for the variable data is controlling the instrument.

The following functions are under its control:

- Watching the frontpanel rotary switches
- Reading the actual front panel keys and softkeys and displaying the actual softkey functions on the C.R.T. screen
- Setting of the acquisition circuits via the MICROPROCESSOR MANAGEMENT INTERFACE
- Performance of calculations
- Control of frontpanel pilot lamp
- CRT display control for traces as well as for text
- Plot output control.
- Performance of the AUTO-SET function (with pushbutton AUTO)
- Programming of the front settings (with pushbutton FRONT No)

Microprocessor management interface

All the frontpanel controls, except the CRT CONTROLS, ILLUM, INTENS, INTENS TEXT, TRACE ROT and the POWER ON switch, are activating the various circuits via the microprocessor control circuits and the MICROPROCESSOR MANAGEMENT INTERFACE.
In this MANAGEMENT INTERFACE also various control signals for the signal acquisition are generated under command of the microprocessor.

Options

The pilot lamp REMOTE as well as the pushbutton URQ can be used when an option is installed.

4.4.6 The front section

All the frontpanel rotary switches, pushbuttons, numerical keyboard and softkeys inform the MICROPROCESSOR system about the user's settings via the FRONT CIRCUIT. The MICROPROCESSOR controls the frontpanel pilot lamps via this FRONT CIRCUIT.

4.4.7 The Power supply section

The power supply, which accepts most mains voltage ranges in use (90-264 Vac), produces the various voltages which are used for the electronic circuits, the EHT voltage for the CRT inclusive.
It also generates a mains voltage related LINE TRIGGER signal, which is fed to the EXTERNAL TRIGGER INPUT circuit for line triggering.

4.5 BRIEF CHECKING PROCEDURE

4.5.1 General information

This procedure is intended to check the oscilloscope performance with a minimum of test steps and actions required.
It is assumed that the operator doing this test is familiar with oscilloscopes and their characteristics.

WARNING: Before switching-on, ensure that the oscilloscope has been installed in accordance with the instructions mentioned in Chapter 3.

NOTE: The procedure does not check every facet of the instrument's calibration; rather, it is concerned primarily with those parts of the instrument that are essential to measurement accuracy and correct operation.
Removing the instrument covers is not necessary to perform this procedure. All checks are made from the outside of the instrument.

If this test is started a few minutes after switching-on, bear in mind that test steps may be out of specification, due to insufficient warm-up time.
The check is set up in a logical sequence. The complete flow should be followed carefully to prevent repeating all control settings and input signals at the start of every single check.
For a complete check of every facet of the instrument's calibration, refer to the section "Performance Check" in the service manual (for qualified persons only).

No additional test equipment is necessary apart from a 10:1 attenuator probe supplied with the oscilloscope and an adaptor BNC female-probe tip (order nr. 5322 263 50022).

4.5.2. Preliminary settings

- Switch the oscilloscope on and check if the power-up routine is executed.
- Connect the CAL signal from the CAL output socket to the A input via the 10:1 att. probe with automatic range adaption BNC plug.
- Press the green pushbutton AUTO; a square wave should become visible on the CRT screen.
- Set the two INTENS controls for the right intensities for trace and text.
- Adjust the FOCUS screwdriver control for a well defined sharp trace and text.
- Set the ILLUM control for the right intensity of the grid illumination.

4.5.3. Trace rotation

- Press pushbutton VERTICAL COUPLING.
- Press softkey GROUND channel A; a straight line should become visible on the screen.
- Set the trace of channel A in the vertical mid-position of the screen by turning the Y-POSITION control.
- Check that the trace lies in parallel with the horizontal graticule lines; if necessary, readjust the TRACE ROT screwdriver control.

4.5.4. Use of probes

The 10:1 passive probes must be properly compensated before use to avoid pulse distortion or amplitude errors at high frequencies. For correct adjustment, refer to section 8.1.1.4.

4.5.5 Vertical

As channels A and B are identical, only the procedure for channel A is described.

4.5.5.1 Vertical mode

- Press the green pushbutton AUTO; a square wave with a vertical amplitude of a few divisions becomes visible on the screen.
- Press pushbutton VERTICAL MODE. Check that channel A is selected.
- Press softkey A and B. Channel B is visible as a straight line.
- Press pushbutton VERTICAL COUPLING.
- Press softkey GROUND of COUPLING B.
- Press pushbutton VERTICAL MODE.
- Press softkey ADD; only the square wave is visible.
- Press softkey A. Check the square wave for minimum jump in vertical direction (< 0,3 div.).
- Press softkey A-INVERT; the square wave is inverted.
- Press softkey A-INVERT; the square wave is inverted again (normal).
- Press softkey PROCESSING; the VERTICAL PROCESSING menu is visible.
- Press softkey MIN / MAX. Check that the straight horizontal parts of the square wave become more frayed.
- Press softkey MIN / MAX again; MIN / MAX is off.
- Press softkey RETURN; the VERTICAL MODE menu appears.

4.5.5.2 Vertical coupling

- Press pushbutton VERTICAL COUPLING. Check that AC coupling is selected.
- Press softkey AC DC of VERTICAL COUPLING A; DC is selected.
- Check that the displayed square wave is shifted upwards with zero line on vertical midposition.
- Press softkey GROUND of VERTICAL COUPLING A. Check that the input signal is switched off, a straight line is visible on the screen.
- Press softkey AC DC of channel A; DC is selected and the square wave is visible again.
- Press softkey OFFSET of channel A.
- Press softkey UP and DOWN and check if the signal moves up and down.

4.5.5.3 Vertical controls

- Press UP/DOWN control AMPL/DIV on it's left side. Check that the amplitude of the square wave on the screen decreases.
- Press UP/DOWN control AMPL/DIV on it's right side. Check that the amplitude increases.
- Turn VARIABLE left. Check that the amplitude decreases and pilot lamp UNCAL lights up.
- Turn VARIABLE right. Check that the amplitude increases and pilot lamp UNCAL extinguishes.
- Turn SHIFT to the right to move the signal up and to the left to move it down.

4.5.6 Horizontal

- Press the green pushbutton AUTO; a square wave of a few periods becomes visible on the screen.
- Press pushbutton HORIZONTAL MODE. Check that RECURRENT and MAX RESOL. are selected.
- Press softkey MAX RESOL. Check that the signal becomes more inquiet.
- Press softkey SING ARMD; after one sweep the screen should stay steady.
- Press softkey SING ARME again. Check that a new sweep is done.
- Press softkey RECURRENT.
- Press UP/DOWN control TIME/DIV on it's left side. Check that more signal periods appear on the screen.
- Press UP/DOWN control TIME/DIV on it's left side until 200 ms/DIV. Check that pilot lamp ALIASED lights up.
- Press UP/DOWN control TIME/DIV on it's right side until 100 ns/DIV. Check that pilot lamp REP ONLY lights up.

4.5.7 Triggering

4.5.7.1 Trigger source

- Press the green pushbutton AUTO.
- Press pushbutton SOURCE. Check that channel A is selected.
- Press softkey B. Check that the oscilloscope is not triggered; the pilot lamp NOT TRIG'D lights up.
- Press softkey LINE; the pilot lamp NOT TRIG'D extinguishes: the signal is still not stable triggered.
- Press softkey A, the oscilloscope is stable triggered.

4.5.7.2 Trigger coupling

- Press the pushbutton COUPLING. Check that AUTO is selected.
- Press softkey AC DC; AC is selected.
- Turn LEVEL and check if the trigger level indicator at the left of the screen moves up and down.
- Check if the oscilloscope is triggered if the trigger level indicator is between the peaks of the signal.
- Press pushbutton NEGATIVE SLOPE. Check that the trigger slope changes and that the pilot lamp in the pushbutton lights up.
- Press pushbutton NEGATIVE SLOPE again; the pilot lamp extinguishes (+ slope).
- Press softkey AUTO.

4.5.7.3 Trigger delay

- Press pushbutton DELAY.
- Press softkey UP. Check that the signal shifts 1 division to the left.
- Press softkey DOWN twice. Check that the signal shifts two divisions to the right.

4.5.8 Display

- Press the green pushbutton AUTO.
- Turn the X-POSITION control. Check that the signal shifts horizontally.
- Turn the Y-POSITION control. Check that the signal shifts vertically.

- Turn the X-EXPAND control. Check that the signal expands and shrinks and check if the pilot lamp UNCAL functions properly (off in CAL position).

4.5.8.1 Magnify

- Press pushbutton MAGNIFY. Check that *1 is selected.
- Press softkeys Y*5, Y*1 and Y/5 and check if vertical magnify functions correctly.
- Press softkey Y*1.
- Press softkey EXPAND several times until *64 is reached.
- Press pushbutton DOTS. Check that the pilot lamp in the pushbutton lights up and the dots are not joined anymore.
- Press pushbutton SMOOTH and check that the trace becomes a line and the pilot lamp in the pushbutton lights up.
- Press pushbutton DOTS twice; check that the pilot lamps DOTS and SMOOTH are off.
- Press softkey *1.

4.5.9 Memory

- Press pushbutton SAVE/PLOT. Check that the menu appears.
- Press pushbutton CLEAR and check that the screen is cleared and refreshed again.
- Press pushbutton LOCK and check that the screen becomes steady and the pilot lamp in the pushbutton lights up.
- Press pushbutton WRITE and check that the pilot lamp in the pushbutton lights up.

4.5.10 Cursor control

- Press the green pushbutton AUTO.
- Press pushbutton CURSOR and check that the menu appears.
- Press softkey ON OFF. Check that two cursors appear on the screen.
- Turn control "1st" and check that the left cursor moves along the signal and that the cursor read out on the C.R.T. is updated.
- Turn control "2nd" and check that the right cursor moves and the read out is updated.

4.5.11 Miscellaneous

- Press pushbutton TRIGGER DELAY.
- Press softkey ENTER.
- Press keys +/- 0 1 2 3 4 and check that the figures appear in the display.
- Press softkey CLEAR.
- Press keys 5 6 7 8 9 and check that the figures appear in the display.
- Press the decimal point key and check that a warning appears in the bottom text area.
- Press pushbutton EXT CLOCK and check that the pilot lamp in the pushbutton lights up and the screen becomes steady.
- Press pushbutton "SETTING FRONT No" and check that the menu appears.
- Press the green pushbutton AUTO to bring the oscilloscope in it's initial state.

5.0 PREVENTIVE MAINTENANCE

5.1 GENERAL INFORMATION

This instrument normally requires no maintenance, since none of its components is subject to wear.
However, to ensure reliable and trouble-free operation, the instrument should not be exposed to moisture, heat, corrosive elements or excessive dust.

5.2 REMOVING THE BEZEL AND THE CONTRAST FILTER

To clean or replace the contrast filter, proceed as follows:

- Push the bezel gently to the right and pull is from the instrument as shown in figure 5.1.

- Remove the contrast filter.

- To prevent scratches, when cleaning the filter, ensure that a clean soft cloth, free from dust and abrasive particles, is used.

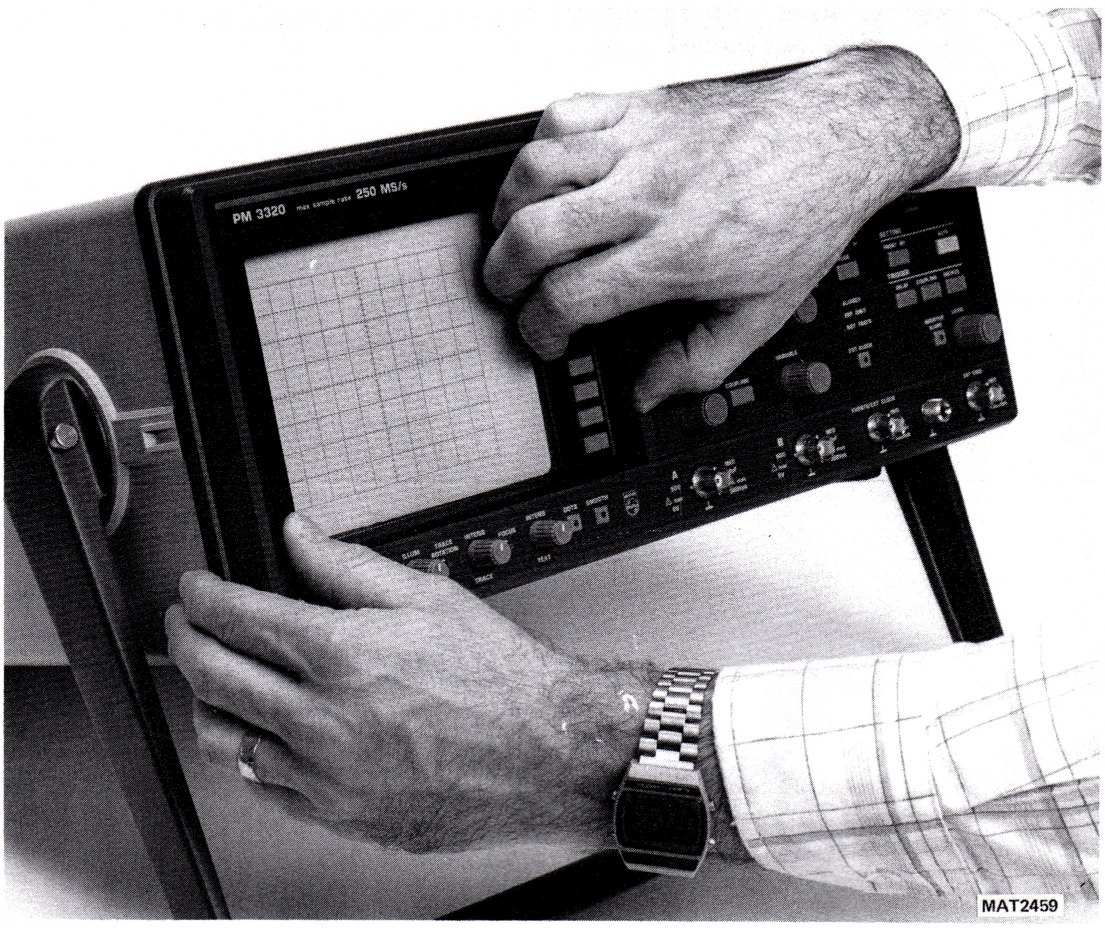


Figure 5.1 Removing the bezel and contrast filter.

5.3 REPLACING THE MEMORY BACK-UP BATTERIES

When message

Back up Battery power too low: consult manual

is displayed, the batteries have to be replaced.

To save the settings and traces which are stored in the memory, it is recommended to switch-on the oscilloscope during the replacement of the batteries.

The two 1.5 V penlight batteries (e.g. Philips LR 6 - see also section 6.15) must be installed as described under section 3.3.

NOTE: It is advisable to remove the batteries when the oscilloscope is stored for longer periods than 24 hours at ambient temperatures below -30°C or above 60°.

IMPORTANT: Under no circumstances should the batteries be left in the oscilloscope at ambient temperatures outside the rated range of the battery specifications!

5.4 RECALIBRATION

From experience, it is expected that the oscilloscope operates within its specifications for a period of at least 1200 hours, or for one year if used infrequently. Recalibration must be carried out by qualified personnel only.

6.0 CHARACTERISTICS

A. General

This instrument has been designed and tested in accordance with IEC publication 348 for Class I instruments.
This specification is valid after the instrument has warmed up for 30 minutes.

Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer.
Numerical values without tolerances are typical and represent the characteristics of an average instrument.
Within 5 minutes after switching on, the temperature difference inside the instrument has reached 70 percent of its end value.

B. Contents

	CHARACTERISTIC	SPECIFICATION	ADDITIONAL INFORMATION
6.1	CATHODE RAY TUBE		
6.1.1	Type	Philips D18-190GH/129	180 mm rectangular single beam tube.
6.1.2	Usefull screen area (h. x w.)	100 mm x 120 mm	For graticule see 6.1.7.
6.1.3	Screen type	GH (P31)	
6.1.4	Total acceleration voltage	16 kV	
6.1.5	Spot size	0,3 mm	Tube only.
6.1.6	Maximum trace distortion		Deviation from straight line.
	-@ screen periphery	1 mm	Outside central 80 mm (vert.) x 100 mm (hor.).
6.1.7	Graticule	Internal, fixed	
	-Illumination	Continuously variable	
	-Size (h. x w.)	80 mm x 100 mm	Centered @ 50 mm from top of CRT screen (hor.) and @ 50 mm from left edge of CRT screen (vert.).
	-Engravings		
	division lines	@ 10 mm	Horizontal and vertical.
	2 mm tick marks	@ 2 mm	On vertical and horizontal central axes.
	0.5 mm tick marks	@ 2 mm	On horizontal lines #2,3,4,6,7,8.
	dots	@ 2 mm	On dotted lines @ 1,5 div and 6,5 div from top of graticule.
	percentages	100-90-10-0 %	To facilitate rise and fall time measurements.
6.1.8	Orthogonality		Measured @ centre of screen.
		$90 \pm 0,5^{\circ}$	(Angle between X and Y axes, when traces are written in X- and Y direction alternately).

6.1.9	Intensity	Blank to max. intens.	Separate front panel controls for trace and text.
6.1.10	Focus	Manually set	Common screwdriver control on front for trace and text.
6.1.11	Trace rotation		Screw driver control on front; direction of screw driver rotation same as direction of trace rotation.
	-Minimum range	14^{o}	Either X or Y trace can be aligned with graticule, when environmental magnetic field is within 0,1 mT.

6.2 SIGNAL ACQUISITION

6.2.1	Sampling type		
	-@ 200 ns/div... 360 s/div:	Real time	
	-@ 5 ns/div... 100 ns/div:	Equivalent time	Random sampling.
6.2.2	Maximum sampling rate		Sampling rate depends on time/div setting.
	-Real time:	250 megasamples/s	
	-Equivalent time:	10 gigasamples/s	Repetitive only.
	-Ext. clock	50 kilosamples/s	Max. aperture uncertainty of 10 us.
6.2.3	Vertical (=voltage) resolution	10 bits	(= 0,1 % of full range).
6.2.4	Horizontal (=time) resolution		
	-In single Ch. or added Ch. acquisition		
	@ 1 ms/div... 5 s/div	4096 samp./acquisition	1 Sample = 0,025 % of full record.
	@ 5 ns/div... 500 us/div	512 samp./acquisition	1 Sample = 0,2 % of full record.
	-In dual channel acquisition		
	@ 1 ms/div... 5 s/div	2048 samp./acquisition	1 Sample = 0,05 % of full record.

	@ 5 ns/div... 500 us/div	512 samp./acquisition	1 Sample = 0,2 % of full record.
6.2.5	Record length	10,2 x time/div	Display in unmagnified position.
6.2.6	Acquisition time		
	-Real time	10,2 x time/div	
	5 s/div ... 1 ms/div	+ 1 ms/div	} Exclusive delay time.
	500 us/div ... 200 ns/div	+ 10 ms	}
	-Equivalent time		
	@ 5ns/div @ 100 ns/div	2 s 10 ms	} After this time there is a 99 % probability of all dots being updated to the new acquisition.
6.2.7	Sources	Channel A Channel B	} Both channels can be inverted before acquisition.
6.2.8	Acquisition modes	1 channel only	Full memory available for 1 channel.
		2 channels	Simultaneously sampled; 2 channels share memory.
		Ch.A and ch.B added	Full memory available for added channels.
		Average	Combined with 1 channel only, 2 channels or ch. A and ch. B added.
		MIN / MAX	Combined with 1 channel only, 2 channels or ch. A and ch. B added.
		Absolute Min/Max	
6.2.9	Maximum time difference	200 ps	Two 2 channels are sampled simultaneously.

6.3 CHANNELS A AND B

6.3.1	Input connector	BNC with probe read-out	Probe read-out causes instrument to change V/div indication, input impedance and attenuator setting according to probe (when fitted with a probe indicator).

6.3.2	Input impedance (In high Z position)		For frequency > 1 MHz see Fig. 6.1.
	-R parallel	1 M Ohm ± 1 %	}In DC position of input }coupling. In AC position }of input coupling.: 18 nF }in series with R par. & }C par. }In 0 position of input }coupling: R par. = @S2
	-C parallel	14 pF	
	-Maximum input capacitance difference	1,5 pF	Capacitance difference between channel A, channel B and/or trigger input.
6.3.3	Input impedance (in 50 ohm position)		
	-R parallel	50 Ohm ± 1 %	In DC, AC and 0 position of input coupling.
	-VSWR (typical)	1,2:1	@ 200 MHz; in AC and DC pos. of input coupling.
6.3.4	Input coupling	a.c. d.c. 0	In 0 position: channel input disconnected from BNC and connected to ground.
6.3.5	Max. input voltage		Instrument should be properly grounded through the protective-ground conductor of the power cord.
	-In high Z position (d.c. + a.c. peak)	300 V	Up to 1 MHz; for freq. > 1 MHz see Fig. 6.2.
	-In 50 ohm position		}
	d.c.	5 V	} Max. 50 mJ during any
	a.c. (r.m.s.)	5 V	} 100 ms interval.
	a.c. (peak)	50 V	}
6.3.6	Deflection coefficient		
	-Steps	5 mV/div...5 V/div	In a 1-2-5 sequence of 10 steps.
	-Vernier ratio	1:2,7	Continuously variable between steps.
	Read out accuracy	± 15 %	
	-Error limit (Ambient:15..35 ^{o}C)		Add 3 % for ambient: 0...50 ^{o}C.
	overall	± 2 %	}
			}Vernier in 0 position.
	up to memory	± 2 %	}Add 2 % in MIN/MAX mode.
	-Non linearity acc. to IEC 351	3 %	
	additional error	± 15 %	Vernier not in 0 position.

6.3.7	Dynamic range	10 div	
6.3.8	D.c. offset control		Related to BNC input.
	-Range (± 5%)		Input voltage within the limits of 6.3.5.
	Att. @ 5 mV/div ...20 mV/div	± 5 V	}In AUTO OFF-SET, the }offset is automatically }controlled such, that }average d.c. level of }signal is presented at }screen centre (± }2 div), provided signal }is within offset range. }Shift is set to zero }(mid) level.
	Att. @ 50 mV/div ...0,2 V/div	± 50 V	
	Att. @ 0,5 V/div ...5 V/div	± 300 V	
	-Resolution (± 5%)		
	Att. @ 5 mV/div ...20 mV/div	5 mV	
	Att. @ 50 mV/div ...0,2 V/div	50 mV	
	Att. @ 0,5 V/div ...5 V/div	0,5 V	
6.3.9	Shift range	± 5 div	From screen centre.
6.3.10	Frequency response (in 50 ohm position)		Z source: 50 Ohm
	-Lower transition point of BW		
	Input coupling in DC position	d.c.	
	Input coupling in AC position	≤ 10 Hz	
	-Upper transition point of BW (Ambient: 15..35^{o}C)	≥ 200 MHz (-3 dB)	Deviation max. 30 MHz for ambient: 0...50^{o}C.
6.3.11	Freq. resp. (In hi.Z pos. through probe)		Z source = 25 Ohm. Probe according to 6.19.
	-Lower transition point of BW		
	Input coupling in DC position	d.c.	
	Input coupling in AC position	≤ 1 Hz	

	-Upper transition point of BW (Ambient: 15..35°C)	≥ 200 MHz (-3 dB)	Deviation max. 30 MHz for ambient: 0...50°C.
6.3.12	Bandwidth limiter		
	-Starting point of HF rejection	20 MHz (-3 dB)	
	-Slope	6 dB/octave	
6.3.13	Pulse response (in 50 Ohm position) (exclusive first mm after transient)		Z source = 50 Ohm; measured over central 6 div.
	-Rise time (Ambient: 15..35°C)	≤ 1,75 ns	(Calculated from bandwidth x Rise time = 0,35). Add max. 0,25 ns for ambient: 0...50°C.
	-Pulse aberrations		Tested with ca 1 ns rise time pulse.
	Overshoot Ringing	} ≤ 6%	During first 10 ns after transient.
6.3.14	Pulse resp. (in hi.Z pos. through probe) (exclusive first mm after transient)		Z source: = 50 Ohm; measured over central 6 div. Probe according to 6.19.
	-Rise time (Ambient: 15..35°C)	≤ 1,75 ns	(Calculated from bandwidth x Rise Time = 0,35). Add max. 0,25 ns for ambient: 0...50°C.
	-Pulse aberrations		Tested with ca 1 ns rise time pulse.
	Overshoot Ringing	} ≤ 6 %	During first 10 ns after transient.
6.3.15	Max. base line instability		
	-Jump (Ambient 15..35°C):		Add 25 % for ambient: 0...50°C.
	when switching to added mode	0,3 div	
	when switching to MIN / MAX mode	0,5 div	
	between any V/div positions	0,15 div	
	when actuating inverter switch	0,3 div	

	between AC, 0 and DC position	0,1 div	
	when rotating vernier	0,6 div	Input externally grounded.
	between any time/div positions	0,6 div	
	when switching to magn. x5	0,5 div	
	-Drift	0,1 div/h	}Measured in 20 mV/div }position.
	-Temperature coefficient	$\pm$ 0,05 div/K	}
6.3.16	Common mode rejection ratio		Both channels @ same attenuator setting; vernier for V/div setting adjusted for optimal CMMR at 10 kHz measured with max. 8 div input signal on each channel, ($\pm$ 4 div around zero).
	-@ 1 MHz	100:1	
	-@ 50 MHz	20:1	
6.3.17	MIN / MAX function		Time base setting 5 us/div ... 360 s/div. Average switched off.
	-Accuracy > 50 %	@ pulse > 3 ns	
	-Reset time	20 ns	
6.3.18	Average		Average formula after the first front change (MIN / MAX switched off). $So(n)=So(n-1)+\frac{Sn-So(n-1)}{C}$
	Constant is max.	64x	
		32 x or off	In ROLL mode.
6.3.19	Cross talk (according to IEC 351)	<-30 dB @ 100 MHz <-50 dB @ 2 MHz	

6.4 TIME BASE

6.4.1 Modes

	Recurrent	
	Single shot	
	Single scan	
	Multiple shot	Up to 4 shots.
	Multiple scan	Up to 4 scans.
	Roll	Can be stopped manually or by trigger.
	Save/Stop on difference	

6.4.2 Time coefficients

-In recurrent	5 ns/div...5 s/div	
-In single scan and multiple scan	5 ns/div...100 ns/div	
-In single shot and multiple shot	200 ns/div...5 s/div	
-In roll mode	50 ms/div...360 s/div	
-With EXT CLOCK	Depending on clock frequency	Input via EXT CLOCK, every clock pulse a sample is taken, so for single channel 4k samples are stored and for dual channel 2 times 2k samples.
-Error limit (Ambient 15..35 ^{o}C)		
In equivalent time mode	$\pm$ 4 %	
In real time mode	$\pm$ 1 %	Add 0,5 % for ambient: 0...50^{o}C.
Up to memory	$\pm$ 0,01 %	

6.5 TRIGGER

6.5.1 Sources

-Signal trigger	Channel A Channel B EXT LINE	
-Events	EXT	Serves as delay to signal trigger.

6.5.2 Input connectors

Input connectors	BNC

6.5.3	Input impedance of EXT trigger inputs		
	-R parallel	1 M Ohm $\pm$ 1 %	In DC position of input coupling.
	-C parallel	14 pF	
	-Max. input capacitance difference	1,5 pF	Difference between channel A, channel B and EXT trigger input.
6.5.4	Coupling		
	-Signal trigger	d.c. a.c. LF rejected HF rejected Auto level TVF	 According to CCIR.
	-Clock & events trigger level	TTL ECL Through variable level	 Adjustable via menu "trigger coupling" - events.
6.5.5	Max. input voltage (d.c. + a.c. peak)		Instrument should be properly earthed through the protective-earth conductor of the power cord.
	-Clock trigger	300 V	
6.5.6	Signal trigger sensitivity (Ambient 15..35°C)		Add 10 % for ambient: 0...50°C.
	-Channel A or B		
	@ 300 MHz @ 200 MHz @ 30 MHz	$\leq$ 4 div $\leq$ 1,5 div $\leq$ 0,5 div	
	-EXT		
	@ 300 MHz @ 200 MHz @ 30 MHz	$\leq$ 300 mV $\leq$ 0,1 V $\leq$ 0,05 V	
	-EXT/10		
	@ 300 MHz @ 200 MHz @ 20 MHz	$\leq$ 3 V $\leq$ 1 V $\leq$ 1 V	

6.5.7	Slope selection	Positive going Negative going Dual slope	Level adjustable; not effective in random sampling and TVF.
6.5.8	Signal level control range		
	-Channel A or B	± 8 div	} }When not in AUTO position
	-EXT	± 0,8 V	}of trigger mode. }
	-EXT/10	± 8 V	}
	-DUAL	± 5 div	}
	-Any source	Related to peak value	}In AUTO position of trig- }ger mode.
6.5.9	Frequency response		Trigger BW not affected by bandwidth limiter.
	-Lower transition point of BW		Ch. A and Ch. B coupling cascaded with trig. coupl.
	Trigger coupling in DC position	d.c.	
	Trigger coupling in AC position	10 Hz (- 3dB)	
	Trigger coupling in LF reject pos.	50 kHz (- 3 dB)	
	-Higher transition point of BW	see also 6.5.6.	
	Trigger coupling in HF reject pos.	50 kHz (-3 dB)	
6.5.10	Trigger delay		
	-Range	-10...9999 div	}can also be indicated in }time.
	@ 5 ns/div ... 100 ns/div	-10...500 div	} }
	-Number of events Max. frequency	1...9999 5 MHz	
	-Accuracy	± 1 %	
	@ 5 ns/div ... 100 ns/div	± 3 % ± 5 ns	

6.6 MEMORY

6.6.1	Memory size		
	-Registers	4	Registers #0, #1, #2, #3
	-Register depth	4096 words	
	-Wordlength	10 bits	

6.6.2	Functions	Clear	Register #0 is cleared, incl. pre-trigger memory and blanked if DOTS is selected.
		Save	Contents of register #0 is saved in selected register (#1, #2 or #3).
		Write	Acquired signal is written into register #0.
		Lock	Memory system is locked, including register #0.
6.7	DISPLAY		
6.7.1	Sources	Register #0 Register #1 Register #2 Register #3	} }In any combination. } }
6.7.2	Display expansion		
	-Horizontal		
	Steps:	1x...64x	Y versus t
		1x...8x	A versus B
	Vernier ratio	1:2	Continuously variable between steps. Recalculated value is displayed with an accuracy of ± 5 %.
	-Vertical		
	Steps:	0.2x, 1x and 5x	Both in Y versus t and Y versus X modes.
6.7.3	Display manipulations	Smooth	Reduces noise by adding a filter in the display section, that is only effective at time base 500 us/div ... 360 s/div.
		Dot join	Linearly interpolated between measured dots.
		Invert	Alle registers can be inverted.
6.7.4	Position range		All channels can be positioned independently.
	-Horizontal	± 5 div	From screen centre.
	-Vertical	± 5 div	From screen centre.

6.8 SETTING MEMORY

6.8.1 Memory size

Max. 251 front settings

6.8.2 Functions

Save	Actual settings are stored in memory, replacing contents of memory cell indicated on CRT.
Insert	Actual settings are stored in memory; insertion is after memory cell indicated on CRT.
Delete	Contents of memory cell indicated on CRT is deleted.
Recall	Actual settings are replaced by contents of memory cell indicated on CRT. Actual settings are saved in "back-up" memory (= mem. cell #0).
(Recall) Next	Actual settings are replaced by contents of memory cell indicated on CRT increased by 1. Actual settings are saved in "back-up" memory (= memory cell #0).
(Recall) Previous	Actual settings are replaced by contents of memory cell indicated on CRT decreased by 1. Actual settings are saved in "back-up" memory (= memory cell #0).

6.9 ANALYZE FACILITIES

6.9.1 Measure

-Amplitude	RMS value	} }Including or excluding
	Mean value	} }offset voltage
	Peak to peak voltage	}Result calculated from
	Peak to zero voltage	}part between cursors or
	Overshoot	}markers if LOCATE is
	Preshoot	}choosen
-Time	Risetime	
	Pulse width	
	Duty cycle	
	Frequency	
	Phase	

6.9.2	Mathematics		
		Add	}
		Subtract	}Results of calculation
		Multiply	}displayed in selected
		Divide	}register and scalable
		Differentiate	}for optimum display
		Integrate	}
		Delay channel	}
		Hystogram	Amplitude density vs. absolute amplitude of an input signal
6.10	AUTO SETTING		
6.10.1	Settling time	Typical 3 s	During plot, AUTO SET is not possible.
6.10.2	CRT functions		
	-Focus	Not influenced	
	-Trace intens	Not influenced	
	-Text intens	Not influenced	
6.10.3	Display functions		
	-Select	To register #0	
	-X-position	Zero	
	-Y-position	Zero	
	-Invert	Off	Only for register #0.
	-X-expand	*1	Vernier calibrated.
	-Y-expand	*1	
	-A versus B	Off	Only for register #0.
	-DOTS	Joined	
6.10.4	Cursors	Off	
	-Calculation	Off	
6.10.5	Text		
	-Reduced	Off	
	-Bottom text lines	Not affected	
6.10.6	Vertical acquisition		
	Y-deflection source	Every source having a triggerable signal at its input	}Channel A if no trigger }is found. }
	Input impedance		
	-Accessory with probe read out	According to probe read out	
	-Otherwise	Not affected by AUTO SET	

Input coupling	ac	
Y-deflection		Each channel is independently set.
-10 mV <input voltage <30 V	Approx. 4 div	} }Vernier in calibrated }position.
-Input voltage <10 mV	Channel at 200 mV/div	} }
		Due to trigger uncertainty at freq. > 60 MHz or at duty cycle <> 50% sensitivity can deviate from above, but signal will remain on the screen.
Channel inverter	Off	
-Add	Off	
-MIN / MAX	Off	
-Bandwidth limiter	Off	
-Average	Off	
-Offset	Not affected	Offset is neglected due to a.c. coupling.
Y base line position		
-In single channel display	Centre of screen $\pm$ 0,3 div	
-In dual channel display		
Ch. A	2 $\pm$ 0,3 div above centre screen	
Ch. B	2 $\pm$ 0,3 div below centre screen	

6.10.7 Horizontal acquisition

Mode	RECURRENT MAX. RESOLUTION	
External clock	Off	
TB deflection coefficient		For TVF not affected.
-Signal frequency 40 Hz ... 80 MHz	Min. 2, max 6 signal periods over 10 div.	
-Signal freq. > 80 MHz	5 ns/div	
-When no trigger found	2 ms/div	

6.10.8 Triggering

-Delay negative delay	Off not affected	For TVF not affected.
-Events	Off	For TVF not affected.
-Source		
Triggerable signal @ ext input	Ext	
No signal @ ext input, but trigg. signal @ channel A or B	Channel A or B	Channel with lowest input frequency is selected. (Channel A when frequencies are equal).
No triggerable signal @ any input	Channel A	
-Mode	Auto	For TVF not affected
	TVF	Trigger on fieldpulse with CCIR TV system.
-Level	50 ... 70% of peak to peak value	Dc component of signal neglected.
-LF reject	Off	
-HF reject	Off	
-Slope	Positive	For TVF not affected.

6.11 CURSORS

6.11.1	Cursor intensity control	Independent of trace intensity but combined with text intensity	
6.11.2	Horizontal resolution		
	-In single channel mode	1 : 4096	
	-In dual channel mode	1 : 2048	
6.11.3	Vertical resolution	1 : 1024	
6.11.4	Read out resolution	3 digits	
6.11.5	Voltage cursors		
	-Error limit Ambient: 15..35°C	± 2 %	Referred to input at BNC, error of probes etc. excluded. Add 3 % for ambient: 0...50°C.
	-Cursor Range	Visible part of signal	Cursors cannot pass each other, (to avoid negative readings).

6.11.6	Time cursors		
	-Error limit	$\pm$ 0,2 %	
6.12	CALIBRATOR		
6.12.1	Wave form		
	-Shape	Square wave	
6.12.2	Internal impedance	50 Ohm $\pm$ 1 %	
6.12.3	Output voltage (peak to peak)	1 V $\pm$ 1 %	Open voltage; (halves when terminated with 50 Ohm). Positive going with respect to ground.
6.12.4	Output current (peak to peak)	20 mA $\pm$ 2 %	Output short circuited; (halves when terminated with 50 Ohm).
6.12.5	Frequency	2 kHz	
6.13	POWER SUPPLY		
6.13.1	Source voltage a.c. (r.m.s)		
	-Nominal	100 V ... 240 V	
	-Limits of operation	90 V ... 264 V	
6.13.2	Source frequency		
	-Nominal	50 Hz ... 400 Hz	
	-Limits of operation	45 Hz ... 440 Hz	
6.13.3	Source waveform characteristics		@ Nominal source voltage.
	-Max. waveform deviation factor	10%	
	-Crest factor	1,27...1,56	
6.13.4	Allowable power source interruption	At least 20 ms	@ Nominal source voltage. After this time oscilloscope settings are saved before instrument goes down. Automatic power up after restoration of Power line voltage. (For setting retention: see 6.15.1).

6.13.5 Power consumption (a.c. source)

-Nominal	160 W

6.14 OPTIONS

For specification of an option refer to the separate manual of the option.

6.15 SUNDRIES

6.15.1 Data and settings retention

Data and settings retention		When instrument is switched off or during line power failure.
-Memory back up voltage	2 V ... < 3,5 V	
-Memory back up current drain	Typical 12 uA	@ 25^{o}C.
-Recommended Batteries:		
type	LR 6	According to IEC 285, (= Alkaline manganese penlight battery), e.g. PHILIPS LR6 (9299 000 20734) or DURACELL MN 1500.
quantity	2 pcs	
-Temperature rise of batteries	20 K	After warming up period of instrument.
-Retention time	Typical 2 years	@ 25^{o}C, with recommended (fresh) batteries.
-Temperature Range	0...+70^{o}C	@ -40...0^{o}C settings retention is uncertain. It is advised to remove batteries from instrument when it is stored during longer period (> 24 h) below -30^{o}C or above 60^{o}C. UNDER NO CIRCUMSTANCES BATTERIES SHOULD BE LEFT IN THE INSTRUMENT @ TEMPERATURES BEYOND THE RATED RANGE OF THE BATTERY SPECIFICATIONS!

6.15.2 Probe Read Out

Probe Read Out		With Philips probe provided with indicator ring.
-Input impedance setting		
Passive high impedance probe	}Fixed @ 1 MOhm	

Sonsle

Passive 50 Ohm probe Passive 50 Ohm attenuator Passive 75 Ohm in 50 Ohm out attenuator Active current probe Active isolation probe	Fixed @ 50 Ohm	
-Vertical sensitivity setting		
Passive probe	Not affected	
Passive attenuator	Not affected	
Active current probe	20 mV/div	Can be manually changed.
Active isolation probe	20 mV/div	Can be manually changed.
-V/div and voltage cursor read out		
Passive 10:1 probe	10 x higher	Offset read out is changed accordingly.
Passive 10 x attenuator	10 x higher	
Passive 100:1 probe	100 x higher	
Passive 100 x attenuator	100 x higher	
Active current probe	In divisions	
Active isolation probe	In divisions	

6.15.3 Analog plot output

-Connector	DIN 5 pole 45^{o}	
-Functions	Screen dump	Included channel identifier.
	Memory dump	Register selectable.
-Sensitivity	1 V/Full screen $\pm$ 3 % 1 V/Full memory $\pm$ 3 %	Horizontal and vertical.
-Pen lift	TTL compatible	Pen-up is selectable (0 or 1). Open collector output; max. 12 V.
-Plot time per dot	20 ms .. 2 s	Software selectable. Signal dependent.
-Plot sequence	Channel A first	In dual channel operation; with more registers starting with the lowest number.

X

6.16 MECHANICS

6.16.1	Height		Fits 5E in 19 inch rack.
	-Without feet and accessory pouch	176 mm (6,9 in.)	Add 15. mm (0,6 in.) for feet.
	-Feet and accessory pouch included	250 mm (9,8 in.)	
6.16.2	Width	419 mm (16,5 in.)	Add 46 mm (1,8 in.) for handle.
6.16.3	Depth		
	-Handle excluded	570 mm (22,5 in.)	Add 35 mm (1,4 in.) for protective front cover.
	-With extended handle	670 mm (26,4 in.)	
6.16.4	Mass	18 kg	
6.16.5	Finish	Epoxy powder coated	
6.16.6	Printed circuit boards	Glass laminate epoxy	
6.16.7	Cooling	Fan aided convection	Maintenance free.

6.17 ENVIRONMENTAL

6.17.1 General

The characteristics are valid only if instrument is checked inaccordance with the official checking procedures. Details on these procedures and failure criteria are supplied on request.

6.17.2	Meets environmental requirements of	MIL-T-28800C Type III Class 5, Style D	
6.17.3	Temperature		Memory back-up batteries removed from instrument, unless batteries meet temperature specifications (see also 6.15.1).
	-Operating		
	Min. low temperature	0^oC	Cf. MIL-T-28800C par. 3.9.2.3 tested cf. par. 4.5.5.1.1.

	Max. high temperature	+ 50°C	Cf. MIL-T-28800C par. 3.9.2.4 tested cf. par. 4.5.5.1.1.
	-Non operating (Storage)		
	Min. low temperature	-40°C	Cf. MIL-T-28800C par. 3.9.2.3 tested cf. par. 4.5.5.1.1.
	Max. high temperature	+ 75°C	Cf. MIL-T-28800C par. 3.9.2.4 tested cf. par. 4.5.5.1.1.
6.17.4	Maximum humidity		Cf. MIL-T-28800C par. 3.9.2.2 tested cf. par. 4.5.5.1.1.
	-Operating and non-operating (Storage)	95% Relative humidity	
6.17.5	Maximum altitude		Cf. MIL-T-28800C par. 3.9.3 tested cf. par. 4.5.5.2. Memory Back-up batteries removed from instrument, unless batteries meet maximum altitude specs.
	-Operating	4,5 km (15000 feet)	Maximum operating temperature derated 3°C for each km (for each 3000 feet) above sea level.
	-Non-operating (storage)	12 km (40000 feet)	
6.17.6	Vibration (Operating)		Cf. MIL-T-28800C par. 3.9.4.1 tested cf. par. 4.5.5.3.1.
	-Freq. 5...15 Hz		
	Sweep time	7 min	
	Excursion (pk to pk)	1,5 mm	
	Max acceleration	7 m/s^2 (0,7 x g)	@ 15 Hz.
	-Freq. 5...25 Hz		
	Sweep time	3 min	
	Excursion (pk to pk)	1,0 mm	
	Max acceleration	13 m/s^2 (1,3 x g)	@ 25 Hz.
	-Freq. 25...55 Hz		
	Sweep time	5 min	
	Excursion (pk to pk)	0,5 mm	
	Max acceleration	30 m/s^2 (3,0 x g)	@ 55 Hz.

	-Resonance dwell	10 min	@ each resonance freq. (or @ 33 Hz if no resonance was found). Excursion cf. 6.17.6.
6.17.7	Shock (Operating)		Cf. MIL-T-28800C par. 3.9.5.1 tested cf. par. 4.5.5.4.1.
	-Amount of shocks		
	total	18	
	each axis	6	(3 in each direction).
	-Shock wave form	half sine wave	
	-Duration	11 ms	
	-Peak acceleration	300 m/s^2 (30 x g)	
6.17.8	Bench handling		Cf. MIL-T-28800C par. 3.9.5.3 tested cf. par. 4.5.5.4.3.
	-Meets requirements of:	MIL-STD-810 methode 516, proced. V	
6.17.9	Salt atmosphere		Cf. MIL-T-28800C par. 3.9.8.1 tested cf. par. 4.5.6.2.1.
	-Structural parts meet requirements of:	MIL-STD-810 methode 509, proced. I salt solution 20%	
6.17.10	EMI (Electro magnetic interface) meets requirements of:	MIL-STD-461 Class B	Applicable requirements of Part 7: CE03, CE07, CS01, CS02, CS06, RE02, RS02, RS03.
		VDE 0871 and VDE 0875 Grenzwertklasse B	
6.17.11	Magnetic radiated susceptibility		Tested conforming IEC 351-1 par. 5.1.3.1.
	-Maximum deflection factor	7 mm/mT (0,7 mm/gauss)	Measured with instrument in a homogeneous magnetic field (in any direction with respect to instrument) with a flux intensity (peak to peak value) of 1,42 mT (14,2 gauss) and of symmetrical sine wave form with a frequency of 45...66 Hz.
6.17.12	Packing		
	Meets requirements of:	NLN-L88	

6.17.13	Transportation		
	Meets requirements of:	AN-D628	
	-Packaged transportation drop		
	meets requirements of:	Mat. safe transp. ass. procedure 1A-B-2	
	-Packed transportation vibration		
	meets requirements of:	Mat. safe transp. ass. procedure 1A-B-1	
6.18	SAFETY		
6.18.1	Meets requirements of:	IEC 348 Class I	
		VDE 0411 Class I	
		UL 1244	
		CSA 556B	
6.18.2	Approvals	VDE 0411 (applied for)	
		UL 1244 (applied for)	
		CSA 556 (applied for)	
6.19	ACCESSORIES		
6.19.1	Accessories furnished with instrument	2 x PM8929/09	10 MOhm, 10:1 passive probe with read out (1,5 m).
		Blue contrast filter	Factory installed.
		Operating manual	
		Front cover Plot probe	
6.20	OPTIONAL VERSIONS		
6.20.1	General		These options can be factory installed only.

6.20.2	Power Cord		Length 2,1m , (82,7 in.).
		Universal european	VDE, KEMA listed.
		U.S.A.	CSA, UL listed.
		United kingdom	BSI listed.
		Swiss	SAV listed.
		Australian	SAA listed.
6.20.3	Cabinet	Rack mount	
6.20.4	IEEE 488/RS232-C interface	Option	
6.20.5	F.F.T. and FILTER	Option	

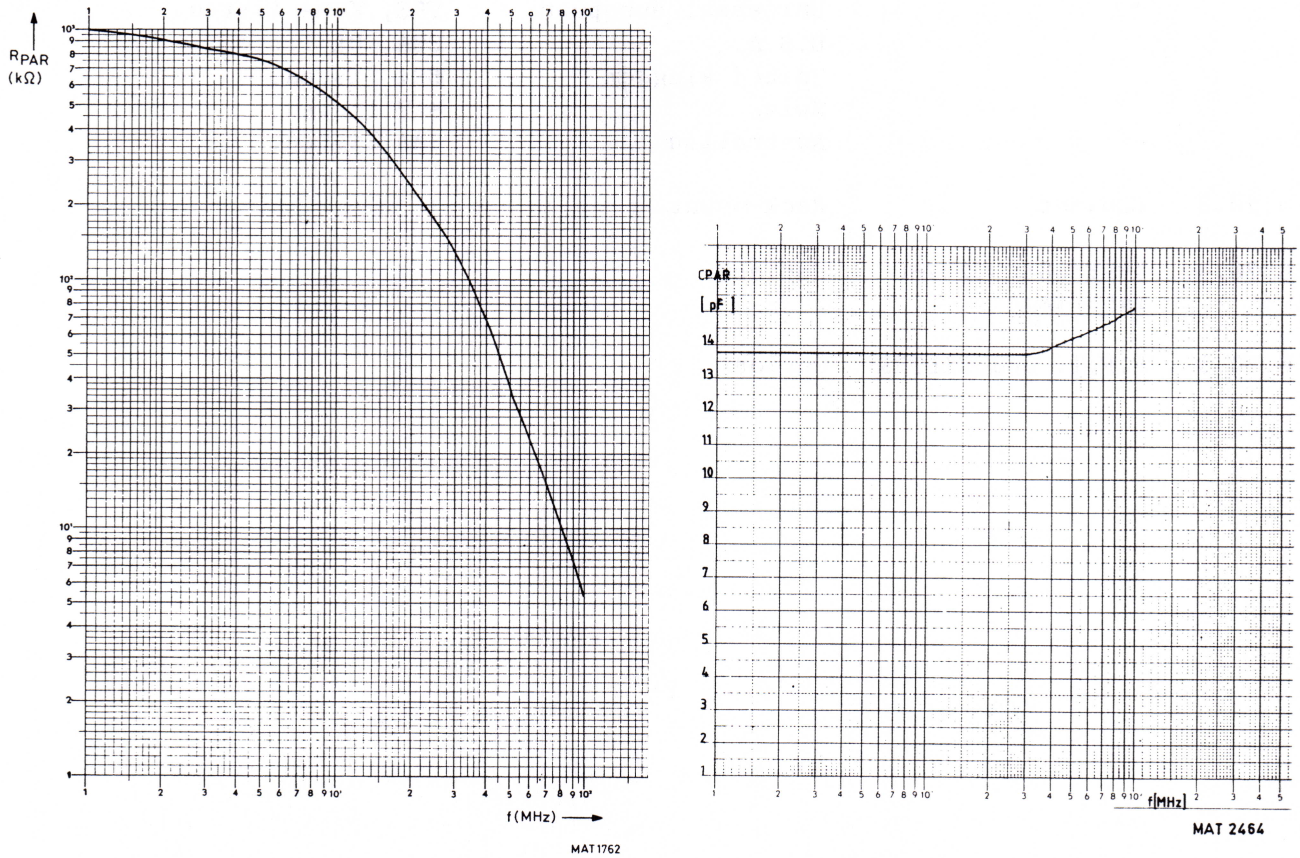


Figure 6.1. Input resistance Rpar. and capacitance Cpar. versus frequency.

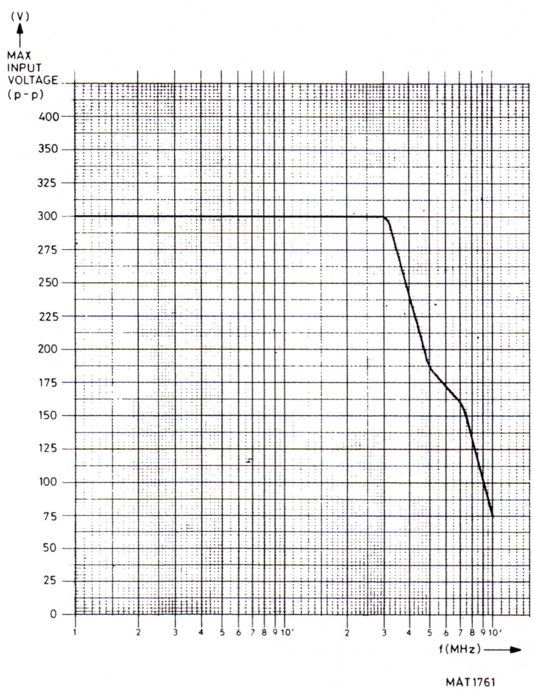


Figure 6.2. Maximum input voltage (peak to peak) derating versus frequency.

7.0 PM3320 VERSIONS - ADDITIONAL INFORMATION

The version of your oscilloscope is indicated on the type plate situated on the rear panel (see fig.7.1.).

The version is indicated as follows:

1	PM3320A/XY	:in type number
2	12nc: 9444 W33 20XYZ	:in code number

WXYZ are represented by numbers.
These numbers are given in this section and each version is briefly described.

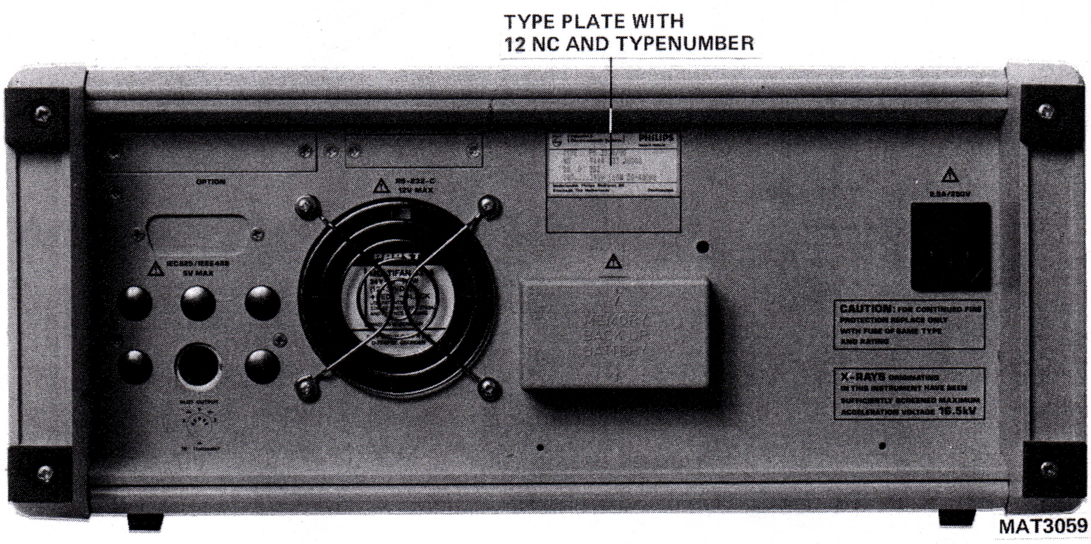


Figure 7.1 Rear panel with indicated type plate position.

Typenumber: PM3320A/XY

Codenumber: 9444 W33 20XYZ

W=1:	Standard version
XY=00	Basic instrument without options.
XY=30	Basic instrument without options but with 19 inch rackmount parts.
XY=40	Basic instrument with IEEE 488/RS232-C option installed.
XY=80	Basic instrument with IEEE 488/RS232-C option installed and with 19 inch rackmount parts.
W=9:	Non standard version

Z: Power-cord-version indication

On type plate on instrument: Z always 0

In the codenumber on the packing in which the instrument was shipped the indication is as follows:

Z=1 Standard European version
220 V / 16 A / 50 Hz

Z=3 U.S.A. version
(U-version)
120 V / 15 A / 60 Hz

Z=4 United Kingdom (UK) version
including line cord plug
fuse of 13A (type C)
240 V / 13 A / 50 Hz

Z=5 Swiss version
220 V / 10 A / 50 Hz

Z=8 Australian version
240 V / 10 A / 50 Hz

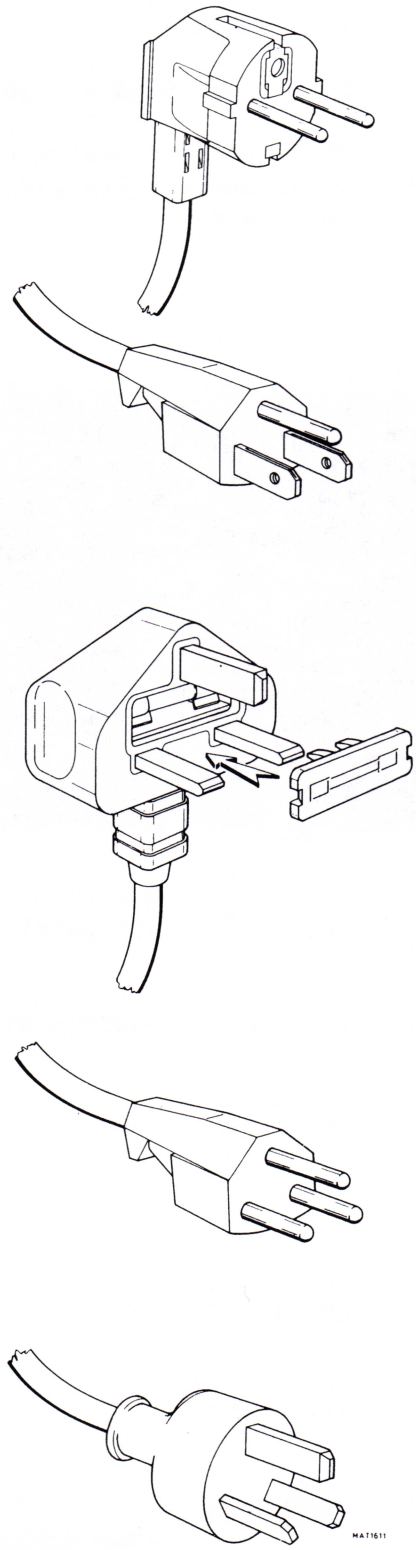


Figure 7.2 Mains connectors.

8.0 ACCESSORY INFORMATION

8.1 ACCESSORIES SUPPLIED WITH THE INSTRUMENT

8.1.1 Passive probe PM8929/09 with automatic range indication

8.1.1.1 Introduction

This 10 x attenuator probe is provided with a special BNC plug with built-in resistor for automatic range indication to advance the V/DIV reading by 10x.

The probe consists of 3 separate units:

-a compensation box having a BNC male connector output,

-a cable assembly,

-a probe body including probe tip and RC assembly.

At delivery the probe has been adjusted to an oscilloscope with an input capacitance of 12pF.

8.1.1.2 Characteristics

- Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer.
- Numerical values without tolerances are typical and represent the characteristics of an average probe.

Electrical

NOTE: These characteristics are valid with a termination of 1 MOhm oscilloscope input, unless otherwise stated.

Designation	Specification	Additional information
Attenuation (d.c.)	10 x + or - 2 %	
Input impedance		
-parallel resistance		
at d.c.	10 MOhm + or - 1,5 %	
at a.c.	see fig. 8.1.	
-parallel capacitance up to 100 kHz	13,5 pF	(for parallel capacitance as function of frequency, see figure 8.1).
Compensation range		
-input capacitance of oscilloscope	5 pF ... 20 pF	

Bandwidth		
-probe only bandwidth at osc. input cap. 10 pF or less	d.c. ... 450 MHz (-3 dB)	
>10 pF	d.c. ... 300 MHz (-3 dB)	
-max.useful system bandwidth at osc. input cap. of 10pF	d.c. ... 300 MHz (- 3 dB)	Note: Up to this freq. the system (probe + osc.) bandwidth is ≥ 95 % of the "osc. only bandwidth".
Pulse response		Aberrations in addition to osc. aberrations. Oscilloscope bandwidth ≤useful bandwidth.
-Ringing during first 30 ns after leading edge	+ or - 5 %, or 7 % pk - pk	
-Ringing thereafter	+ or - 2 %	
-Tilt	≤ 2 %	
Signal delay	7,6 ns + or - 200 ps	Measured between tip to BNC-output connector.

Maximum voltage		
-max. non destructive input voltage (d.c. + a.c. peak)	500V	0...2 MHz approx. for derating see figure 8.2.
-test voltage (d.c.): type test	2,42 kV	During 1 min (resistance value adapted to test)
-performance check	2,42 kV	During 1 sec

Mechanical				
-Dimensions	length	width	height	
probe body	57 mm	14 mm(max)		
cable assy	1500 mm	9 mm(max)		
compensation box	38 mm	16 mm	15 mm BNC excluded	
pouch	275 mm	195 mm		
-Mass	137 g			Standard probe with accessories in pouch.

Environmental

The characteristics are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS-organisation in your country, or by PHILIPS, INDUSTRIAL AND ELECTRO-ACOUSTIC SYSTEMS DIVISION, EINDHOVEN, THE NETHERLANDS.

Operating temperature	-10 °C ... +55 °C
Storage temperature	-62 °C ... +85 °C
Maximum humidity	95 % relative humidity
Altitude	
-operating	To 4500 m
-non-operating	To 12000m
Vibration (operating)	
- freq. 5...15 Hz	7 min each axis, excursion 1,5 mm (p-p) and 7 m/s^2(0,7 g) acceleration at 15 Hz.
- freq. 15...25 Hz	3 min each axis, excursion 1 mm (p-p) and 13 m/s^2(1,3 g) acceleration at 25 Hz.
- freq.25...55 Hz	5 min each axis, excursion 0,5 mm (p-p) and 30 m/s^2(3 g) acceleration at 55 Hz.
Resonance dwell	10 min at each resonance freq.
Shock (operating)	300 m/s^2 (30 g), half sine-wave shock, duration is 11 ms.(3 shocks per direction for a total of 18 shocks).

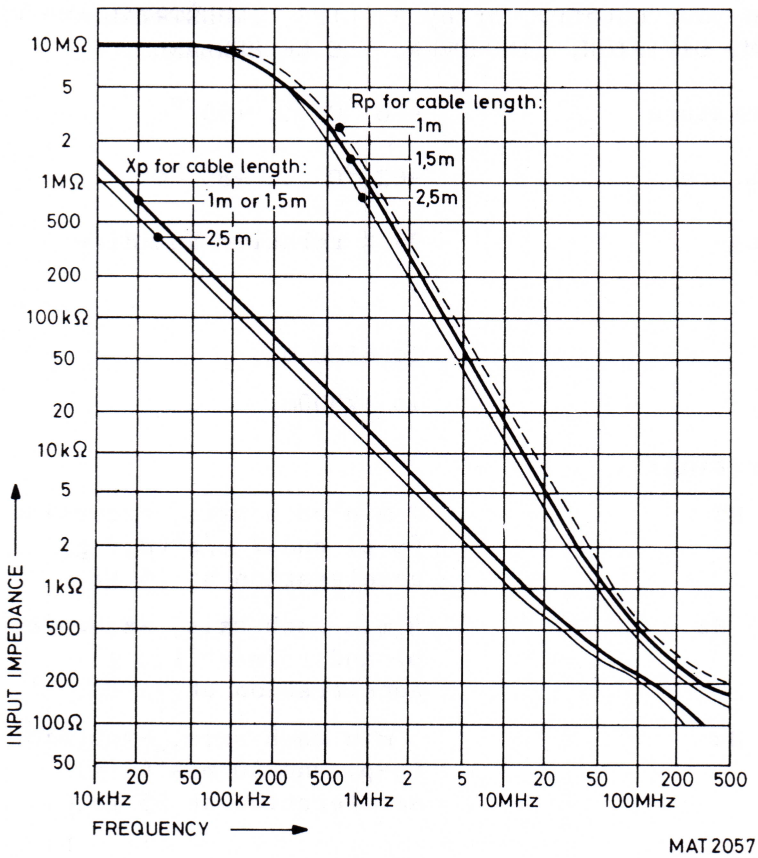


Figure 8.1. Input impedance v.s. Frequency.

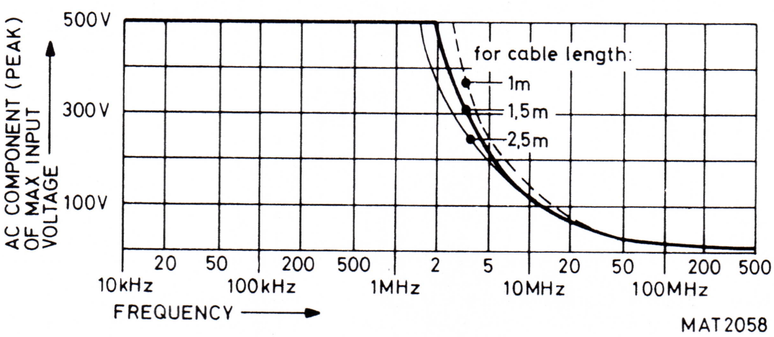


Figure 8.2. AC component (pk) of max. input voltage v.s. Frequency.

Accessories

-Accessory kit, contents:
- Earth cable
- Spring-loaded test clip
- Set marking rings
- Probe tip (2x)
- Insulating cap
- DIL cap
- Wrap pin adapter
- Earth bus

- Instruction manual

8.1.1.3 Description of accessories

Earth cable: To minimize ringing in a signal, an earth cable is provided. This cable must first be plugged onto the probe body and then be connected to the nearest earth point of the circuit to be measured.

Spring-loaded test clip: This is a provision for hands-free connection to a test point or component lead.

Marking rings: At delivery a set of 3 different colour marking rings (red, white and blue) are provided. This can be used to help identify the specific probes when using more than one probe on an oscilloscope.

Probe tip: A spare set of 2 probe tips are standard supplied with the probe. When a probe tip is damaged it can be pulled out by means of a pair of pliers. Then a new tip must be firmly pushed in.

Insulating cap: An insulating cap is provided to cover the metal part of the probe during measurements in densely wired circuits.

D.I.L. cap: This is a cap facilitating measurements on dual-in-line integrated circuits.

Wrap pin adapter: The wrap pin adapter is a provision to make hands-free connection to a wire wrapped pin circuit.

Earth bus: This is a provision to minimize ringing in VHF signals, when earthing must be as short as possible.

8.1.1.4 Adjustments

Matching the probe to your oscilloscope

The measuring probe has been adjusted and checked by the manufacturer. However, to match the probe to your oscilloscope, the following manipulation is necessary.

- Connect the measuring pin to the CAL-socket of the oscilloscope.
- A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response, see figure 8.3, 8.4 and 8.5.

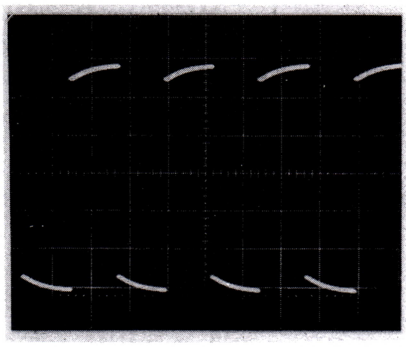


Figure 8.3 Over-compensation

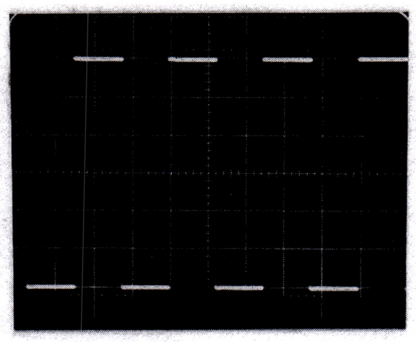


Figure 8.4 Correct compensation

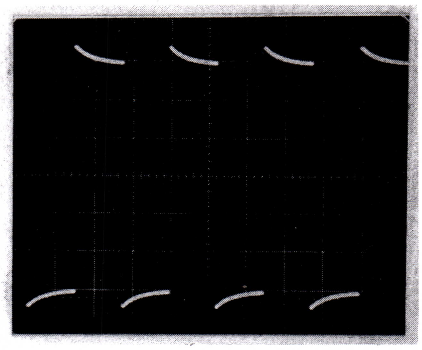


Figure 8.5 Under-compensation

8.1.2 Blue contrast filter

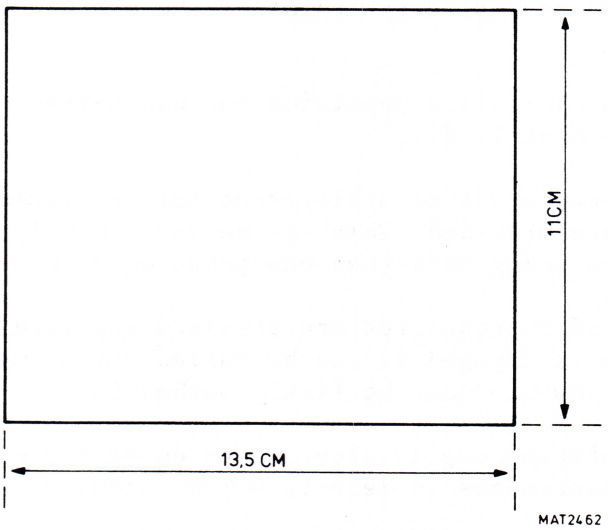


Figure 8.6 Blue contrast filter. (Factory installed !)

8.1.3 Front cover

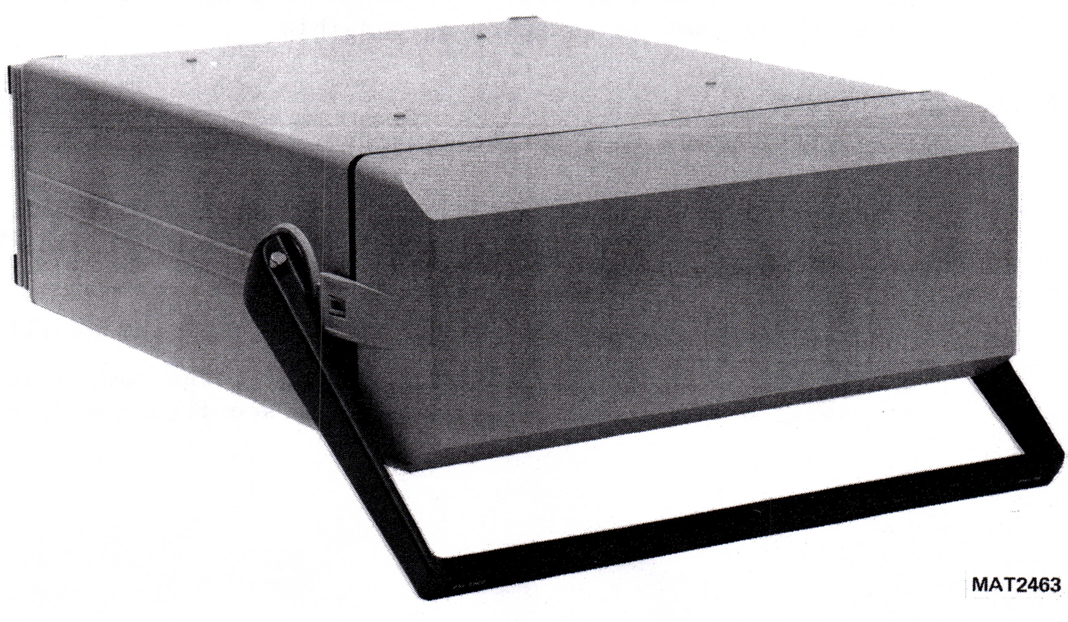


Figure 8.7 Oscilloscope with front cover.

8.2 OPTIONAL ACCESSORIES

8.2.1 IEEE 488/RS232-C bus intelligent interface PM 8956

The IEEE 488/RS232-C is a general-purpose bus interface designed according to the IEEE 488/RS232-C standard. This option can be either retrofitted or factory installed. It enables the oscilloscope to be used in a measuring system together with other IEEE 488/RS232-C bus compatible instruments.
For installation instructions and detailed operating and programming information concerning this facility, refer to the programming manual.